(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 774 605 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.05.1997 Bulletin 1997/21

(51) Int Cl.[6]: **F16K 11/056**, B01D 35/04

(21) Application number: **96308321.7**

(22) Date of filing: **18.11.1996**

(84) Designated Contracting States:
BE DE DK ES FR GB GR IT PT SE

(30) Priority: **17.11.1995 JP 300247/95**
19.12.1995 JP 349220/95

(71) Applicant: **TORAY INDUSTRIES, INC.**
Tokyo 103 (JP)

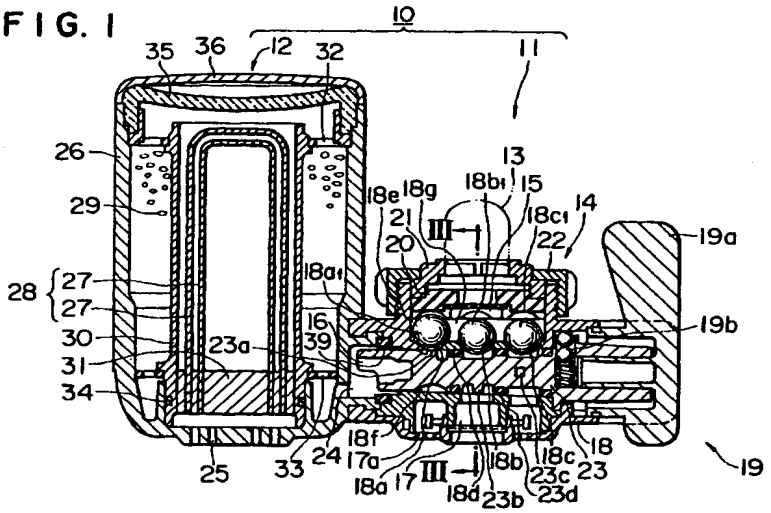
(72) Inventors:
- **Yonezawa, Yasuo**
  Nagoya-shi, Aichi, 457 (JP)
- **Itakura, Jyunji**
  Gamou-gun, Shiga, 521-13 (JP)
- **Isobe, Takashi**
  Otsu-shi, Shiga, 520 (JP)
- **Tamatsu, Sho**
  Yamashina-ku, Kyoto-shi, Kyoto, 607 (JP)

(74) Representative: **Coleiro, Raymond et al**
MEWBURN ELLIS
York House
23 Kingsway
London WC2B 6HP (GB)

(54) Multi-way valve and water purifier using the same

(57) A multi-way valve comprises a valve casing (18) having a fluid inlet (15) and a plurality of fluid outlets (16, 17, 17a), first and second chambers (18e, 18f) defined in the valve casing (18), a partition (18d) disposed between the first and second chambers (18e, 18f) and having in it a plurality of fluid apertures (18a, 18b, 18c), leading to respective fluid paths in the second chamber a plurality of valve elements ($18a_1$, $18b_1$, $18c_1$) each engaging a corresponding aperture (18a, 18b, 18c) from the first chamber side for opening and closing the respective fluid paths and a valve actuator (23) having cams (23a, 23b, 23c) which selectively push the valve elements ($18a_1$, $18b_1$, $18c_1$) upwardly from the second chamber side. The multi-way valve can be manufactured as a small-sized unit, and therefore, a water purifier (10) using the valve can also be a small-sized assembly.

FIG. 1



EP 0 774 605 A1

Printed by Jouve, 75001 PARIS (FR)

Description

The present invention relates to a multi-way valve, a water purifier using the same and a method for distributing or mixing a fluid, and more particularly to a multi-way valve for distributing or mixing a fluid and a water purifier and a fluid distributing or mixing method using this multi-way valve.

As conventional multi-way valves for distributing or mixing a fluid, a so-called rotary-type valve wherein fluid paths are switched by rotating a seal member (for example, U.S. Patents 4,172,796, 4,770,768 and 5,160,038) and a so-called sliding-type valve wherein fluid paths are switched by linearly moving a seal member have been broadly used. However, any of these multi-way valves has problems with durability and sealing property of a seal member. Therefore, in order to solve these problems, the following valves have been proposed. (1) a multi-way valve wherein a plurality of spherical elements for closing fluid paths are provided in a valve casing having a single chamber, and any one spherical element is pressed and moved in a circumferential direction of the casing by rotating a rotatable shaft for opening a corresponding fluid path (for example, Japanese Utility Model Publication HEI-7-12770) (2) a multi-way valve wherein a fluid inlet and a plurality of fluid outlets are provided to a valve casing as well as spherical elements are provided for closing the respective fluid outlets, and any spherical element is moved in a direction parallel to an axis of a rotatable member by rotating the rotatable member for opening a corresponding fluid outlet (for example, Japanese Utility Model Laid-Open HEI-4-132271) (3) a multi-way valve wherein a fluid inlet and two fluid outlets are provided to a valve casing, balls closing the fluid outlets by a pressure of water supplied from the fluid inlet are provided, and any ball is displaced from a valve seat by the rotating operation of a shift arm for opening a corresponding fluid outlet (for example, Japanese Utility Model Laid-Open HEI-6-16778)

However, in a case where a multi-way valve described in the above (1) is employed, because the spherical element must be moved in a circumferential direction by rotating the rotatable shaft, the amount of movement of the spherical element inevitably becomes great, and there is a defect that the multi-way valve becomes large-sized. If the multi-way valve becomes large-sized, the amount of resident fluid in the valve increases and there is a problem of becoming poor in hygienic property originating from the great amount of the resident fluid. Further, because the spherical elements must be taken off by disassembling the valve casing when the spherical elements are checked or exchanged for checking or improving the sealing ability due to the spherical elements, the work for the taking-off or exchange of the spherical elements becomes remarkably troublesome. Furthermore, there is a further problem that the shape of the rotatable shaft and the inside shape of the valve casing are complicated and the multi-way valve becomes expensive.

In a case where a multi-way valve described in the above (2) is employed, because the spherical element must be moved in a direction parallel to the axis of the rotatable member by rotating the rotatable member, the amount of movement of the spherical element in the direction of the axis of the rotatable member becomes great, and there is a defect that the multi-way valve becomes large-sized. If the multi-way valve becomes large-sized, the amount of resident fluid in the valve increases and there is a problem of becoming poor in hygienic property originating from the great amount of the resident fluid. Further, because the spherical elements must be taken off by disassembling the valve casing when the spherical elements are checked or exchanged for checking or improving the sealing ability due to the spherical elements, the work for the taking-off or exchange of the spherical elements becomes considerably troublesome.

In a case where a multi-way valve described in the above (3) is employed, because the ball must be moved in a single chamber of the valve casing by rotating the shift arm, the size of the chamber inevitably becomes great, and there is a defect that the multi-way valve becomes large-sized. If the multi-way valve becomes large-sized, the amount of resident fluid in the valve increases and there is a problem of becoming poor in hygienic property originating from the great amount of the resident fluid. Further, because the balls must be taken off by disassembling the valve casing when the balls are checked or exchanged for checking or improving the sealing ability due to the balls, the work for the taking-off or exchange of the balls becomes remarkably troublesome. Furthermore, because the shape and the attachment condition of the shift arm must be set in proper conditions, the multi-way valve must be assembled with meticulous care and there is a fear causing a defective, and as a result, there occurs a problem that the multi-way valve becomes expensive.

Further, a multi-way valve having an inflow path and a plurality of outflow paths wherein the fluid paths are switched particularly by a pushing member is also known.

As this type of multi-way valve, as disclosed in Japanese Utility Model Publication SHO 63-8460 and Japanese Utility Model Laid-Open SHO 60-151972, there is a cylinder-piston type valve comprising a cylinder having a fluid inlet and fluid outlets and a piston sliding in the cylinder and having a seal member. Further, as disclosed as switching valves in JP-A-SHO 48-10631 and JP-A-SHO 52-45732, there is a ball-type valve closing a fluid outlet by a ball and opening the fluid outlet by moving the ball.

However, in the former cylinder-piston type multi-way valve, because the seal member fixed to the piston is slid on the fluid inlet or the fluid outlet of the cylinder while being pressed, there is a problem that an abrasion

quickly progresses and the seal member must be exchanged in a short period of time.

On the other hand, in the latter ball-type multi-way valve, because the fluid paths are switched by rolling the ball provided as a seal member, the problem with abrasion such as one in the former valve can be improved. However, because an operating lever connected to an operating member provided for moving the ball extends through a valve box and both end portions thereof protrude outside of the valve box, a motion of grasping one end of the lever to pull the lever or pushing the other end of the lever is required for the switching operation, and such an operation is inconvenient and cannot be easily performed.

In order to improve such a problem, a valve enabling to operate only at one end of an operating lever is proposed, for example, as a ball-type water passage switching device for a faucet described in Japanese Utility Model Publication SHO 51-26357. In this switching device for a faucet, however, because a certain length is required for a rotatable shaft of an operating lever extending through a wall of a switching chamber in a direction perpendicular to the wall and a seal member must be provided for sealing the rotatable shaft, the valve body tends to become large-sized in the axial direction of the shaft and such a valve is not preferred as a valve for a faucet of an ordinary home. Further, because most of faucets for an ordinary home are formed as a type in which a discharge pipe can be rotated in right-hand and left-hand directions (clockwise and counterclockwise directions), the method for operating an operating lever by moving the lever in right-hand and left-hand direction has a problem that the operation is not easy because the discharge pipe is rotated together with the operating lever.

Further, JP-B-HEI-5-31036 discloses a ball-type check valve for water in which an operating lever is moved in frontward and rearward directions relative to a discharge pipe. In this check valve, however, because pushing rods for moving balls, springs and seal members are required by the same number as that of fluid outlets, the number of parts increases and the structure of the valve becomes complicated.

It would be desirable to provide a multi-way valve which can be formed small-sized as a whole, can decrease the amount of resident fluid therein and can facilitate the work for taking off and exchanging valve bodies, and a water purifier and a method for distributing or mixing a fluid using the multi-way valve.

Further, it would be desirable to provide a multi-way valve which can switch fluid paths easily and appropriately and whose mechanism for valve switching operation can be simplified, and a water purifier for using the multi-way valve.

A multi-way valve according to the present invention comprises a valve casing having:

(1) one of (a) a valve inlet for entry of fluid into the valve and a plurality of valve outlets for supply of fluid from the valve to different respective locations; and

(b) a plurality of valve inlets for receipt of fluid from different respective sources and a valve outlet for supply of a mixture of the fluids from the respective sources;

(2) a first chamber communicating with the or each valve inlet;

(3) a second chamber communicating with the or each valve outlet;

(4) a partition having a plurality of apertures therein;

(5) means defining one of:

(a) separate respective fluid paths within the second chamber leading respectively from each said aperture to a corresponding said outlet of the plurality thereof; and

(b) separate respective fluid paths within the first chamber leading respectively from each said fluid inlet of a plurality thereof to a corresponding said aperture;

(6) a plurality of valve elements disposed generally within one of the first and second chambers and cooperable one with each respective said aperture so as to be capable of closing the respective aperture; and

(7) valve operating means operable within the other of the said first and second chambers to push any one or more said valve element(s) away from the or each respective aperture and thereby selectively open one or more of the said fluid paths. In this valve, especially where the valve elements are in the second chamber, they may be biased towards their closure or opening position by biasing means such as a spring. However, when the valve elements are in the first chamber, they are preferably biased towards their closure position merely by their weight and fluid pressure.

A first multi-way valve according to the invention is a valve casing having a fluid inlet and a plurality of fluid outlets; a first chamber and a second chamber defined in said valve casing, the first chamber communicating with the fluid inlet, the second chamber communicating with the plurality of fluid outlets, respectively; a partition disposed between the first and second chambers and separating the first and second chambers, the partition having a plurality of fluid paths provided in correspondence with the plurality of fluid outlets and capable of communicating the first and second chambers to each other; a plurality of valve elements each engaging a corresponding fluid path of the plurality of fluid paths from a side of the first chamber and opening and closing the corresponding fluid path; and a driving device having cams which selectively drive the plurality of valve elements from a side of the second chamber (hereinafter,

referred to as a first multi-way valve).

In this first multi-way valve, the valve elements are preferably formed as spherical elements. Further, it is preferred that each of the valve elements formed as spherical elements comprises a core composed of a rigid material and an elastic material provided on the surface of the core. The driving device preferable comprises a rotatable body on which the cams are arranged along an axial direction of the rotatable body. Further, for example, this first multi-way valve can be formed as a structure wherein communicating paths are formed between the plurality of fluid paths and the plurality of fluid outlets, respectively, and the respective communicating paths are separated from each other by the driving device.

Further, another multi-way valve according to the present invention comprises a valve casing having a fluid inlet and a plurality of fluid outlets; at least one spherical element disposed in the valve casing for opening and closing the fluid outlets; a contact member brought into contact with the spherical element, the contact member moving to open and close the fluid outlets by displacing the spherical element; a movable member moving the contact member; a pushing member driving the movable member by pushing operation of the pushing member; and a temporarily stopping mechanism for temporarily stopping the movable member at a predetermined position (hereinafter, referred to as a second multi-way valve).

In this second multi-way valve, the movable member, for example, may be moved reciprocatively and the pushing member may drive the movable member so as to push the contact member via the movable member. The temporarily stopping mechanism may comprise, for example, a guide cylinder having a same number of deep grooves and shallow grooves defined on an inner surface of the guide cylinder to end in an axial direction of the guide cylinder, the deep grooves and shallow grooves being arranged alternately in a circumferential direction of the guide cylinder and defining linear guide convex portions between respective adjacent deep grooves and shallow grooves, an end surface of each linear guide convex portion and an end surface formed at a position corresponding to an end portion of each shallow groove adjacent to each linear guide convex portion being formed as a slope such as a continuous slope; a reciprocating cam member having reciprocating cams slidable along the deep grooves and shallow grooves; a rotating cam member engaged to the movable member and having rotating cams slidable only along the deep grooves; and means for urging the movable member toward the rotating cam member. Further, it is preferred that a rotation preventing member is provided in the valve casing for preventing rotation of the contact member. Furthermore, it is preferred that the contact member comes into contact with a spherical surface of the spherical element at a position eccentric from a center of gravity of the spherical element toward the fluid outlets. A ratio of a diameter of the spherical element to an inner diameter of the fluid outlets is preferably in the range of 1:0.3 to 1:0.8.

A water purifier according to the present invention has a multi-way valve for switching raw water flown in to at least one of a plurality of outflow destinations and means for filtering the raw water flown in through the multi-way valve. The multi-way valve may be any of those of the invention described above.

The multi-way valve may comprise a valve casing having a fluid inlet and a plurality of fluid outlets; a first chamber and a second chamber defined in the valve casing, the first chamber communicating with the fluid inlet, the second chamber communicating with the plurality of fluid outlets, respectively; a partition disposed between the first and second chambers and separating the first and second chambers, the partition having a plurality of fluid paths provided in correspondence with the plurality of fluid outlets and capable of communicating the first and second chambers to each other; a plurality of valve elements each engaging a corresponding fluid path of the plurality of fluid paths from a side of the first chamber and opening and closing the corresponding fluid path; and a driving device having cams which selectively drive the plurality of valve elements from a side of the second chamber. Hereinafter, this water purifier is referred to as a first water purifier.

In this first water purifier, preferred aspects of its multi-way valve are the same as those of the aforementioned first multi-way valve.

Further, another water purifier according to the present invention has a multi-way valve for switching raw water flown in to at least one of a plurality of outflow destinations and means for filtering the raw water flown in through the multi-way valve, and the multi-way valve comprises a valve casing having a fluid inlet and a plurality of fluid outlets; at least one spherical element disposed in the valve casing for opening and closing the fluid outlets; a contact member brought into contact with the spherical element, the contact member moving to open and close the fluid outlets by displacing the spherical element; a movable member moving the contact member; a pushing member driving the movable member by pushing operation of the pushing member; and a temporarily stopping mechanism for temporarily stopping the movable member at a predetermined position. Hereinafter, this water purifier is referred to as a second water purifier.

In this second water purifier, preferred aspects of its multi-way valve are the same as those of the aforementioned second multi-way valve.

The above-described first and second water purifiers can be applied to a water purifier formed so that both the multi-way valve and the filtering means thereof are attached to a faucet. Alternatively, they can be applied to a water purifier wherein only the filtering means thereof or both the multi-way valve and the filtering means thereof are placed on a base. Namely, they can be

formed as any type of water purifier of a so-called cartridge-type water purifier directly attached to a faucet and a so-called top sink-type water purifier.

Further, a method for distributing or mixing a fluid according to the present invention is a method particularly using the first multi-way valve. Namely, the method according to the present invention is a method for distributing a fluid introduced from a single fluid inlet to at least one of a plurality of fluid outlets, or mixing fluids introduced from a plurality of fluid inlets by supplying the fluids to a single fluid outlet, and the distributing or mixing method comprises the steps of interposing fluid paths corresponding to the plurality of fluid outlets or the plurality of fluid inlets between a first chamber communicating with the single fluid inlet or the plurality of fluid inlets and a second chamber communicating with the plurality of fluid outlets or the single fluid outlet; closing the fluid paths by valve elements provided in the first chamber utilizing self-weights of the valve elements and a fluid supply pressure; and driving at least one of the valve elements selectively from a side of the second chamber for opening at least one of the fluid paths by pushing up a corresponding valve element in accordance with a predetermined fluid distributing or mixing condition.

In the first multi-way valve, the fluid paths communicating the first and second chambers are surely closed by the valve elements utilizing the self-weights of the respective valve elements and a pressure of the supplied fluid and a good sealing ability can be indicated. A part of the valve elements are or is selectively moved toward the first chamber by driving the driving device, a corresponding fluid path is opened, and the fluid is supplied to the second chamber through the opened fluid path. A desired fluid distribution or mixing can be achieved by this opening operation of the selected fluid path. When the fluid path is opened, because the selected valve element may be slightly moved toward the first chamber side by the operation from the second chamber side, the amount of the movement of the valve element decreases as compared with conventional multi-way valves. As a result, the multi-way valve can be formed small-sized as a whole and the amount of resident fluid in the valve can be reduced.

Further, when required to take off or exchange the valve elements, because only the first chamber may be opened, the work required can be greatly facilitated as compare with the work in a conventional multi-way valve in which the whole of the multi-way valve must be disassembled.

Furthermore, when the valve element is formed as a spherical element and it is constructed from a core of a rigid material and an elastic material layer covering the surface of the core, an impact caused when the valve element closes a corresponding fluid path can be greatly decreased and abrasion of the corresponding portions can be suppressed, as well as a good sealing ability can be achieved by the elastic material layer.

In the water purifier using this first multi-way valve, either the condition purifying the raw water or the condition flowing the raw water out as it is can be easily selected, and the whole of the water purifier easily can be formed small-sized.

Further, in the method distributing or mixing a fluid using the first multi-way valve, the fluid paths can be surely closed by the self-weights of the valve elements and a fluid supply pressure, and a good sealing ability can be indicated. When a selected fluid path is opened, the corresponding valve element closing the fluid path may be merely slightly moved by pushing up the valve element from the second chamber side. Therefore, a desired fluid distribution or mixing can be easily and surely performed by a simple and a small amount of operation.

In the second multi-way valve, when the pushing member provided to the valve casing is pushed, the movable member transmits the movement of the pushing member to the contact member provided in the valve casing. Then, the contact member forcibly displaces at least one spherical element provided as a valve element by the above-described operation. The spherical element closes (or opens) a predetermined fluid outlet of a plurality of fluid outlets provided to the valve casing. At that time, the temporarily stopping mechanism operates and the movable member is temporarily stopped at a predetermined position, and the condition where the spherical element closes (or opens) the fluid outlet can be maintained. When the pushing member is pushed again, the lock due to the temporarily stopping mechanism is released and the movable member returns to an initial position, and the spherical element opens (or closes) the fluid outlet via the operation of the contact member.

In such an operation, because the contact member can forcibly displace a spherical element provided in the valve casing via the movable member merely by a single pushing operation by the pushing member, the switching mechanism for the valve can be simply constructed, and the plurality of fluid outlets can be opened and closed easily and appropriately.

Further, in a case where the temporarily stopping mechanism having the guide cylinder is employed, the reciprocating cam member is slid along the deep and shallow grooves by the operation of the pushing member, and the rotating cam member is also slid in the guide cylinder by sliding the rotating cams, which are engaged with the reciprocating cams, along the deep grooves. When the rotating cams are pushed up to the end surfaces of the guide convex portions, the rotating cams slide on and along the slopes formed at the end surfaces of the respective guide convex portions by the operation of the urging means, and whereby each rotating cam engages each shallow groove and the guide convex portion adjacent to the shallow groove. In such a manner, the movable member and the contact member engaging the rotating cam member are temporarily stopped at a predetermined position. When the pushing

member is pushed again, the engaged cams are pushed by the reciprocating cams, the urging means operates at a position of the end surface of each guide convex portion, each rotating cam slides along a slope of an adjacent guide convex portion, and then the rotating cam slides along an adjacent deep groove to return to an initial condition.

In such a structure, because the temporarily stopping mechanism is simply constructed from a single guide cylinder, reciprocating cam member, rotating cam member and urging means such as a spring, the number of the parts may be small, and the multi-way valve can be assembled compactly and inexpensively.

Further, in a case where the rotation preventing member is provided in the valve casing, the contact member can be prevented from being rotated, and the spherical elements can be forcibly displaced at a stable condition to switch the fluid paths.

Further, in a case where the contact member comes into contact with a spherical surface of the spherical element at a position eccentric from a center of gravity of the spherical element toward the fluid outlet when the fluid outlet is opened, the spherical element fitting into the fluid outlet can be pushed up by a small force. As a result, the pushing member operating to move the contact member can also be operated by a small operating force.

Furthermore, in a case where the ratio of a diameter of the spherical element to an inner diameter of the fluid outlet is set in the range of 1:0.3 to 1:0.8, a defect such as one caused by a condition where the difference between the diameter of the spherical element and the inner diameter of the fluid outlet is small, namely, a defect that the spherical element is deeply fitted into the fluid outlet and a great force is required when opened can be prevented. Moreover, a defect caused by a condition where the inner diameter of the fluid outlet is extremely small, namely, a defect that the pressure loss of the multi-way valve itself becomes great and the flow rate remarkably decreases also can be prevented.

In addition, the above mentioned means for moving the spherical valve elements utilizing a contact member which carries the valve elements allows them to move linearly without forward or backward rotational movement when moving between opening and closure positions.

Preferred exemplary embodiments of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a vertical sectional view of a water purifier using a multi-way valve according to a first embodiment of the present invention;

FIG. 2 is a right-hand side view of the water purifier shown in FIG. 1.

FIG. 3 is an enlarged vertical sectional view of the water purifier shown in FIG. 1, as viewed along III-III line of FIG. 1.

FIG. 4 is an exploded perspective view of a part of the multi-way valve shown in FIG. 1.

FIG. 5 is an enlarged sectional view of a valve element of the multi-way valve shown in FIG. 1.

FIG. 6 is a perspective view of a part of the water purifier shown in FIG. 1, showing a bayonet mechanism employed for the main body side of the water purifier.

FIG. 7 is a perspective view of a part of the water purifier shown in FIG. 1, showing a bayonet mechanism employed for the filter device side of the water purifier.

FIG. 8 is an elevational view of a water purifier according to a second embodiment of the present invention.

FIG. 9 is an enlarged vertical sectional view of the water purifier shown in FIG. 8, as viewed along IX-IX line of FIG. 8.

FIG. 10 is a vertical sectional view of the water purifier shown in FIG. 9, as viewed along X-X line of FIG. 9.

FIG. 11 is a cross-sectional view of the water purifier shown in FIG. 9, as viewed along XI-XI line of FIG. 9.

FIG. 12 is an exploded perspective view of a part of a multi-way valve incorporated in the water purifier shown in FIG. 9.

FIG. 13 is a schematic view showing a undesirable condition of contact of a member and an element in the multi-way valve incorporated in the water purifier shown in FIG. 9.

FIG. 14 is a perspective view of a contact member according to a modification of the multi-way valve incorporated in the water purifier shown in FIG. 9.

FIG. 15 is a perspective view of a contact member according to another modification of the multi-way valve incorporated in the water purifier shown in FIG. 9.

FIG. 16 is an enlarged vertical sectional view of a guide cylinder of the multi-way valve incorporated in the water purifier shown in FIG. 9.

FIG. 17 is a developed view of the inner surface of the guide cylinder shown in FIG. 16.

FIG. 18A is a side view of a reciprocating cam member shown in FIG. 12 and FIG. 18B is an elevational view thereof.

FIG. 19A is an elevational view of a rotating cam member shown in FIG. 12 and FIG. 19B is a side view thereof.

FIGS. 20A to 20C are developed views of the inner surface of the guide cylinder and the respective members showing the operation of a temporarily stopping mechanism.

FIG. 21 is a plan view of a part of a multi-way valve according to a modification of the multi-way valve incorporated in the water purifier shown in FIG. 9.

FIG. 22 is a plan view of a part of a multi-way valve according to another modification of the multi-way

valve incorporated in the water purifier shown in FIG. 9.

FIG. 23 is a perspective view of a top sink-type water purifier according to a third embodiment of the present invention.

FIG. 24 is an enlarged vertical sectional view of a filter device of the water purifier shown in FIG. 23.

FIG. 25 is an elevational view of a joint of the water purifier shown in FIG. 23.

FIG. 26 is an exploded perspective view of a part of the water purifier shown in FIG. 23.

FIG. 27 is an elevational view of an inlet of a multi-way valve incorporated into the water purifier shown in FIG. 23.

FIG. 28 is a vertical sectional view of a bayonet mechanism employed in the water purifier shown in FIG. 23.

FIG. 29 is a sectional view of the bayonet mechanism shown in FIG. 28 for explaining an operation condition of the bayonet mechanism.

FIG. 30 is a sectional view of the bayonet mechanism shown in FIG. 28 for explaining another operation condition of the bayonet mechanism.

Hereinafter, the preferred embodiments of the present invention will be explained with reference to the drawings.

Although the embodiments described hereinafter will be explained with respect to water purifiers incorporating multi-way valves according to the preferred embodiments of the present invention, of course, the multi-way valves can be applied to devices and apparatuses other than water purifiers and uses of the multi-way valves are not limited to the water purifiers.

FIGS. 1 to 7 show a water purifier using a multi-way valve according to a first embodiment of the present invention. FIG. 1 is a vertical sectional view of the water purifier, FIG. 2 is a right-hand side view of the water purifier and FIG. 3 is a vertical sectional view of the water purifier shown in FIG. 1 as viewed along III-III line of FIG. 1.

A water purifier 10 of this embodiment comprises a water purifier body (valve body) 11 comprising a multi-way valve which switches untreated tap water flowing in from a faucet 13 to one of a plurality of outflow destinations, and an exchangeable cartridge-type filter device 12 (hereinafter, also referred to as "a filter containing cartridge" or merely "cartridge") provided as means for filtering the untreated tap water flowing in through the multi-way valve. The water purifier 10 is attached directly to the faucet 13 by a fastener 14 provided in the water purifier body 11.

The water purifier body 11 has a body 18, and the body 18 has an inlet 15 which is a fluid inlet for the tap water flowing in from the faucet 13 at an upper position of the body, a transfer port 16 for supplying the tap water to the filter containing cartridge 12 laterally of the body, and a supply port 17 for allowing the untreated tap water to flow out as it is and a shower supply port 17a for supplying the untreated tap water as a shower of water at a lower position of the body. A switching valve 19 for switching the flow path of the tap water to a selected direction is provided in the body 18. A fastener 14 for connecting the body 18 to the faucet 13 is provided on an upper portion of the body 18. As shown in FIG. 1, the fastener 14 comprises a ring-like rubber packing 20, a presser ring 21 and a cap 22, and the fastener 14 has a structure such that it can connect the body 13 to the faucet 13 by cooperation of a female screw thread at the internal periphery of the cap 22 with a male screw thread at the external periphery of the body 18 in a manner such that water leakage does not occur.

The body 18 has an interior divided by a partition 18d so as to provide respective chambers separate from one another, namely an upper chamber 18e formed as a first chamber and a lower chamber 18f formed as a second chamber. Three apertures 18a, 18b and 18c are provided in the partition 18d to allow fluid passage through partition 18d. The respective apertures 18a, 18b and 18c are spaced apart from one another along a longitudinal path extending parallel to a spool shaft 23 of a switching valve 19 connected to spool shaft 23. The inlet 15 is provided in and allows communication with the upper chamber 18e for passage of untreated tap water into the body 18. On the other hand, the transfer port 16, supply port 17 and the shower supply port 17a are three outlets for untreated tap water provided in and allowing communication from the lower chamber 18f for passage of untreated tap water out of the body 18. The apertures 18a, 18b and 18c allow communication between the upper and lower chambers 18e, 18f to provide a continuous flow path. Three spherical valve elements $18a_1$, $18b_1$ and $18c_1$ are provided in the upper chamber 18e such that the respective valve elements can engage the respective corresponding apertures 18a, 18b and 18c under liquid hermetic sealing conditions and lower end portions of the respective valve elements can project into the interior of the lower chamber 18f so as to engage with the respective apertures. Therefore, when the valve elements $18a_1$, $18b_1$ and $18c_1$ are taken off for checking or exchanged, the work therefor can be performed very easily by removing the fastener 14 from the body 18 and opening the upper chamber 18e from the upper side.

In the switching valve 19, as shown also in FIG. 4, annular rings 23e are disposed circumferentially around the spool shaft 23 and seal rings 23d are provided on the respective rings 23e. By engaging the seal rings 23d with the internal periphery of the lower chamber 18f under liquid hermetic sealing conditions, respective water flow paths are defined which communicate the apertures 18a, 18b and 18c with the transfer port 16, the supply port 17 and the shower supply port 17a, respectively, and the respective water flow paths are also separated from each other. Cams 23a, 23b and 23c are provided at predetermined positions on the spool shaft 23 (posi-

tions predetermined in correspondence with the respective apertures) for pushing up corresponding valve elements. Each of these cams 23a, 23b and 23c can selectively push a corresponding valve element upwardly by rotating the spool shaft 23 at an angle of, for example, 90 degrees. In this manner, the extent to which a valve element is to be raised may be set to be in a range of 1 to 2 mm for ensuring passage of a sufficient amount of water through a given aperture. Therefore, the body 18 having the upper chamber 18e and the lower chamber 18f can have a small size and ultimately, the amount of resident water can be decreased to realize improved hygiene conditions.

A selected valve element among the valve elements $18a_1$, $18b_1$ and $18c_1$ is pushed up by rotating the spool shaft 23 at a predetermined angle by the operation of a switching lever 19a to open a corresponding water path, and the inlet 15 can be selectively communicated with one of the transfer port 16, the supply port 17 and the shower supply port 17a.

A click stopping mechanism 19b is provided on the spool shaft 23 for easily setting a predetermined position of the spool shaft 23. The click stopping mechanism 19b comprises a spring 19d inserted into a hole 19c provided in a surface of the spool shaft 23 and two balls 19e and 19f urged by the spring 19d.

Supporting plates 18g are provided on the partition 18d, and the supporting plates 18g prevent the valve elements $18a_1$, $18b_1$ and $18c_1$ from being moved laterally.

As shown in FIG. 5, each valve element (shown as valve element $18a_1$ in FIG. 5) preferably comprises a core $18a_2$ composed of, for example, a steel ball, and an elastic material layer $18a_3$ covering the whole surface of the core $18a_2$ and having a thickness of about 0.5 to 1 mm. With such a valve element, the sealing ability due to the valve element and the durability of the valve element and the valve seat therefor can be greatly improved. The valve element may be formed as a cone shape or a cylinder shape, and the elastic material layer $18a_1$ may not be provided in a case where sufficiently good sealing ability and durability can be ensured without the elastic material layer.

As the material of the elastic material layer $18a_3$, a rubber such as a nitrile rubber, an ethylene-propylene rubber, a fluoro rubber, a silicone rubber and a butyl rubber can be appropriately employed, and in particular, a rubber having a rubber hardness of 50 to 90 degrees can be adequately employed. The other valve elements $18b_1$ and $18c_1$ can be formed similarly.

The cartridge 12 containing a filter comprises a container 26 having an inflow port 24, for receiving untreated tap water, in a side wall thereof and a plurality of shower ports 25 (ports for supply of filtered water) in a bottom portion thereof. The container 26 contains a U-shaped hollow fiber bundle 28 formed from a plurality of hollow fibers the open ends of which are set so as to face the shower ports 25, and an adsorbent layer 29 charged between the outer surface of a cylindrical member 30, which is provided in the container 26, and the inner surface of the container 26. As the adsorbent of the adsorbent layer 29, an activated carbon, a zeolite, an ion exchange resin or a xylene resin is preferably used.

The hollow fiber bundle 28 is provided within the cylindrical member 20 both ends of which are open. The respective hollow fibers of the hollow fiber bundle 28 are bent into a U-shaped configuration and both ends of the respective hollow fibers are potted into a synthetic resin member 31 provided at a lower axial end region of the cylindrical member 30 so that both ends can open downwardly, the open ends of the respective hollow fibers thereby facing the shower supply ports 25.

The cylindrical member 30 is fixed at an upper axial end portion to the inner surface of the container 26 via a filter 32, and at a lower axial end portion thereof is fixed in the container 26 via a filter 33 provided with a plurality of holes. The lower axial end portion of the cylindrical member 30 sits in an upstanding short, cylindrical part projecting axially from the bottom portion of the container 26 and centrally of the container 26. An O-ring 34 sits within a recess in the side wall of the cylindrical member 30 at its lower axial end to provide a seal between the concentric surfaces of the cylindrical part 30 and the short cylindrical part in which it sits.

A transparent lid 35 is provided at an upper axial end of the container 26 so that the hollow fiber bundle 28 and the adsorbent layer 29 can be easily charged and the degree of soiling of the hollow fiber bundle 28 can be easily observed from outside. A removable opaque cover 36 is provided on the transparent lid 35 so that a double covering structure can be formed.

In the cartridge 12 thus constructed, a path of water to be filtered is provided, this extending from the inflow port 24 to the supply port 25 through the adsorbent layer 29 and the hollow fiber bundle 28. The cartridge 12 containing the filter is thus constructed integrally. The cartridge 12 is connected to the water purifier body 11 by a bayonet mechanism described below via a ring-like rubber packing 39, and the body 11 is connected to the faucet 13 to form the water purifier 10.

The bayonet mechanism, which affords detachable engagement of the cartridge 12 with the purifier body 11, is constructed as shown in FIGS. 6 and 7. The bayonet mechanism comprises a generally concave portion 37 defined by an end portion (shown in the drawing as a left hand end portion) of the spool shaft 23 in the water purifier body 11; which protrudes radially outwardly from the side wall of the body 18, and a generally convex portion 38 defined by an external periphery of the inflow port 24 of the cartridge 12, the respective concave and convex portions 37 and 38 being profiled so as to provide a mechanism for mutual attachment to and detachment from one another. The above detachable engagement occurs between the concave portion 37 on the spool shaft 23 and the convex portion 38 on the inflow

port 24. Alternatively, the detachable engagement may occur between a concave portion defined by an appropriate protrusion from the cartridge side and a convex portion defined by an appropriate protrusion from the water purifier body side. In the embodiment shown in FIG. 7, the convex portion 38 is defined by the external periphery of the inflow port 24 which is profiled so as to provide a pair of part circumferential convex projections extending radially outwardly of the inflow port 24. Each convex projection has a tapered screw portion 38a having a predetermined length in the circumferential direction of the inflow port 24 in which the thickness in the axial direction varies around the circumference of the inflow port 24 to provide a taper angle of θ, and a stop 38b connected to the tapered screw portion 38a at its thickest circumferential end and extending in the axial direction of the inflow port 24. Although, in the embodiment, a pair of convex projections each having a tapered screw portion 38a is provided, two or more pairs of convex projections may be provided. It is advantageous to provide two or more pairs of such projections because it is then possible to decrease the rotational angle required for fixing the filter containing cartridge 12 to the water purifier body 11.

The concave portion 37 comprises notched portions 37a each having a circumferential length greater than the length L of the sum of the tapered screw portions 37b each engaging a corresponding tapered screw portion 38a and having a predetermined length. Both of the convex projections of the convex portions 38 are inserted into the respective notched portions 37a of the concave portion 37, the cartridge 12 is rotated after the insertion, and the tapered surfaces 38c of the tapered screw portion 38a are slid along the respective female screw portions 37b and engaged with the female screw portions 37b. When the end portions of the female screw portions 37b are brought into contact with the respective stops 38b, the fastening operation is completed. In this embodiment, the stops 38b are disposed at positions such that the cartridge 12 stands up in a vertical direction as shown in FIG. 1 when the end portions of the female screw portions 37b are brought into contact with the respective stops 38b.

In the water purifier 10 of this embodiment thus constructed, the water purifier body 11 and the cartridge 12 containing the filter are connected such that they assume the respective states shown in FIGS. 6 and 7. In this condition, when the position of the switching lever 19a is observed from the right-hand side of FIG. 6, it is at the 12 o'clock position.

Firstly, when the switching lever 19a is rotated in a clockwise direction to be set at the 3 o'clock position, the tap water, supplied from the faucet 13 and flowing into the valve from the inlet 15, flows along the water path 18b, opened by pushing up the valve element $18b_1$ by the operation of the cam 23b of the spool shaft 23, around the spool shaft 23, and out through the supply port 17, to provide a substantially linear flow of water.

When the switching lever 19a is rotated in a counterclockwise direction at an angle of 90 degrees to be returned to the 12 o'clock position, the valve element $18b_1$ is moved down by being released from the cam 23b of the spool shaft 23 and the water path 18b is closed. Instead, the valve element $18c_1$ is pushed up by the cam 23c of the spool shaft 23 and the water path 18c is opened. The tap water introduced from the inlet 15 flows along the water path 18c around the spool shaft 23, and the flow of the water supplied is switched to a shower flow, the water flowing out through the shower supply port 17a.

When the switching lever 19a is further rotated in the same counterclockwise direction at an angle of 90 degrees to be sent to the 9 o'clock position, the valve element $18a_1$ is pushed up by the cam 23a of the spool shaft 23 and the water path 18a is opened. The water path is switched, and the tap water introduced from the inlet 15 is supplied to the water transfer port 16 along the water path 18a. The tap water having reached the transfer port 16 is supplied to the inflow port 24 of the cartridge 12 containing the filter. At that time, because the cartridge 12 and the water purifier body 11 are securely connected to each other by the bayonet mechanism via the ring-like rubber packing 39, the water does not leak from this portion, and flows through this portion smoothly. The tap water supplied to the inflow port 24 passes from the filter 33 through the adsorbent layer 29 and the hollow fiber bundle 28 in this order, and the water is filtered in this portion and the filtered water flows out from the supply port 25 as a purified water.

Next, a water purifier using a multi-way valve according to a second embodiment of the present invention will be explained with reference to FIGS. 8 to 20. In this embodiment, a water purifier having a ball-type multi-way valve, attached to, for example, a faucet for homes, will be explained.

FIG. 8 shows a water purifier according to a second embodiment of the present invention attached to a faucet, FIG. 9 is an enlarged vertical sectional view of the water purifier shown in FIG. 8, as viewed along the line IX-IX of FIG. 8, FIG. 10 is a vertical sectional view of the water purifier shown in FIG. 9, as viewed along the line X-X of FIG. 9, and FIG. 11 is a cross-sectional view of the water purifier shown in FIG. 9, as viewed along the line XI-XI of FIG. 9.

As shown in FIG. 8, a water purifier 101 of this type comprises a valve body 102 (hereinafter, also referred to as merely "a body") having incorporated therein a multi-way valve 105 and a filter device 103 containing a filter material. A faucet 104 is attached to the upper portion of the body 102. Because the filter device 103 has substantially the same structure as that of the filter-containing cartridge of the aforementioned first embodiment, the structure of the filter device 103 of this embodiment is only briefly explained later. The tap water introduced from the faucet 104 is supplied from the outlet of the body 102 in a direction shown by broken line

arrows in FIG. 8, and the water filtered by the filter device 103 is supplied from the outlet of the filter device 103 as purified water in a direction shown by a solid line arrow in FIG. 8.

As shown in FIGS. 9 to 11, the body 102 has a valve structure comprising a valve casing 107 provided in a housing 106, two balls 111 and 112 (spherical elements) provided in the valve casing 107, and a valve operating portion 108 for operating the balls 111 and 112 by a push button 110 provided as a pushing member at a front position of the housing 106. Hereinafter, the ball 111 is also referred to as a first ball, and the ball 112 is also referred to as a second ball.

A bottom portion of the valve casing 107 carries apertured lateral projections capable of receiving screws engageable within corresponding screw fastening elements within the housing 106 and upstanding from a base thereof so as to secure the valve casing 107 to the housing (see FIG. 9). As shown in FIG. 11, in this embodiment there are three such screw fastening arrangements, one rearwardly and one forwardly of this valve casing 107. An upper portion of the valve casing 107 projects from an upper opening of the housing 106 and a ring-like packing 115 is fitted into a stepped portion formed in the upper portion of the valve casing 107. The water purifier 111 is attached to the faucet 104 by providing split ring 116 above a radially protruding portion shown by a two-dot chain line in FIG. 9, fastening the split ring 116 and screwing an attachment nut 117 onto the upper portion of the valve casing 107 via the split ring 116.

In the lower portion of the housing 106, as shown in FIG. 10, a shower discharge port 118 for discharging the untreated tap water introduced from the faucet 104 as it is, and a transfer port 119 for supplying the introduced tap water to the filter device 103 are provided. Namely, the ball-type multi-way valve 105 provided in the water purifier 101 of this embodiment switches the water paths to the shower discharge port 118 for using the untreated tap water introduced from the faucet 104 as it is and to the transfer port 119 for supplying the introduced tap water to the filter device 103. A packing 120 is interposed between the housing 106 and the valve casing 107 within the housing 106 in the vicinity of the shower supply port 118.

Hereinafter, a particular valve mechanism associated with the multi-way valve 105 will be explained.

A plate member 122 having many small through holes is fitted to an inlet 121 of the valve casing 107 for receiving impure water. As shown in FIGS. 9 and 11, a first outlet 131 communicating with the shower discharge port 118 and a second outlet 132 communicating with the transfer port 119 are provided in the bottom portion of the valve casing 107, and the outlets 131 and 132 open at respective positions shifted from each other in a frontward/rearward direction. In particular, the first outlet 131 communicating with the shower discharge part 118 is disposed forwardly of the second outlet 132 communicating with the transfer port 119. The respective ports are also spaced apart laterally from one another. The power of the tap water introduced from the faucet 104 is reduced by the plate member 122 attached to the inlet 121, and the tap water flows into the interior of the valve casing 107 smoothly. When the power of the tap water is not so strong, it is not particularly necessary to provide the plate member 122.

The first ball 111 for opening and closing the first outlet 131 and the second ball 112 for opening the closing the second outlet 132 are contained in the valve casing 107. In this embodiment, the first and second balls 111 and 112 are formed from a rubber such as a nitrile rubber, a silicone rubber, a fluoro rubber or an ethylene-propylene rubber. The hardness of the rubber is preferably in the range of 40 to 90 degrees, and such a rubber, which is an elastic material, can manifest a good sealing ability. The ratio of the diameter of the first or second ball 111 or 112 to the inner diameter of the first or second outlet 131 or 132 respectively is preferably in the range of 1:0.3 to 1:0.8 so that the ball does not fit deeply into the outlet and the pressure loss of the outlet is not great. The material of the first and second balls 111 and 112 is not particularly restricted to rubber, and it may be a metal such as a steel, a stainless steel or an aluminum, a plastics material such as an ABS resin or a polypropylene, or a ceramic . In a case where the ball is constructed from a relatively hard material such as a metal or a ceramic, it is preferred that a rubber is attached to a portion of the valve casing 107 which comes into contact with the ball when the outlet is closed by the ball, thereby obtaining a good sealing ability. Furthermore, if a metal core is contained in the ball, the weight of the ball is increased, and the sealing ability can be improved by the sealing operation due to the increased self-weight of the ball in addition to the pressure of a supplied tap water.

Next, the valve operating portion 108 will be explained with reference to FIG. 12. FIG. 12 is an exploded perspective view showing the valve operating portion 108 after removing the push button 110.

As shown in FIG. 12, the valve operating portion 108 comprises a support member 141 supporting the first and second balls 111 and 112 and holding the balls in the valve casing 107, a push button 110 provided in front of the housing 106 (FIGS. 9 and 11), a movable member 142 capable of reciprocating in the forward and rearward directions for transmitting displacement of the push button 110, also by a pushing operation, to the support member 141, and a stopping mechanism 143 interposed between the push button 110 and the movable member 142 for temporarily stopping the movement of the movable member 142 at a predetermined position.

As shown in FIGS. 9 to 12, the support member 141 supports the first and second balls 111 and 112 in a condition such that the balls can roll, and the support member 141 is slidable along an inner surface at the base of the valve casing 107 in the forward and rearward directions. A first hemisphere-shaped supporting hole 151

and a second hemisphere-shaped supporting hole 152 are provided in the support member 141, and the first and second balls 111 and 112 are inserted into and held in the first and second hemisphere-shaped supporting holes 151 and 152, respectively. By the sliding motion of the support member 141 in the forward and rearward directions, one of the first and second balls 111 and 112 is fitted into either one of the first and second outlets 131 and 132 staggered in respective positions one forwardly of the other to close the one of the outlets 131 and 132, and the other ball opens the other outlet.

An upper end of a flange 153 upstanding from the upper surface of the support member 141 is received by a recess 154 provided in a rib depending from the lower surface of the plate member 122 fitted across the inlet 121, so as to prevent rotation of the support member 141, while leaving it free to slide. By such a rotation preventing mechanism, the rotation of the support member 141 can be prevented during the sliding operation described later, and the support member 141 can retain a stable condition during sliding. Notched portions 156 and 157 are formed in the lower surface of the support member 141, which notched portions define respective recesses extending radially outwardly from the first and second supporting holes 151 and 152, respectively, to respective opposite peripheral edges of the support member 141, so as to facilitate the outflow of the tap water to the respective outlets 131 and 132. Furthermore, a connecting piece having in it a cavity 158 is provided on the front surface of the support member 141 for connection of the support member 141 with the reciprocating movable member 142.

The axis of the movable member 142 is disposed at a position eccentric relative to the centre of gravity Q of ball 111 or 112 toward the outlets 131 and 132 by an amount E (shown in Fig. 9), and the support member 141 comes into contact with the ball 111 or 112 at a surface portion thereof eccentric relative to the centre of gravity Q of ball 111 or 112 toward the outlets 131 and 132. As a result, the support member 141 can be pushed so as to carry the ball 111 or 112 fitted into the outlet 131 or 132 on receiving only a relatively small operating force and can therefore switch the outlet 131 or 132 from a closed condition to an opened condition by a relatively small operating force. As shown in FIG. 13, if the support member 141 came into contact with the ball 111 or 112 at an upper surface position relative to the centre of gravity Q of the ball 111 or 112 and operated, because a force directed downward operates (shown by arrows in FIG. 13) to press the ball onto the outlet, an unnecessary great force would be required even if the outlet could be opened (FIG. 13 shows an exaggerated deformation of the ball 111 (112)).

The support member 141 may be modified and there are various configurations which may be employed. For example, it may take the form of a branch-like shape as shown in FIG. 14, or may take the form of a cap-like shape as shown in FIG. 15. Moreover, in the embodiment shown in FIGS. 8 to 12, the projection upstanding from the base of the support member 141 and serving to allow prevention of rotation of the support member 141 is a flange 153. However, the projection 153 may also be modified and may take the form, for example, of a rod-like portion or a cone-like portion as shown in FIGS. 14 and 15. Furthermore, in the above embodiments, the upstanding projection 153 and the recess 154 are provided to cooperate at an upper end of the support member 141. However, they may be disposed on a side or bottom surface of the support member 141.

As shown in FIGS. 9 and 12, the movable member 142 (reciprocating movable member) for sliding the support member 141 in forward and rearward directions is slidably inserted into a cavity 158 in a connecting piece at a front surface of the valve casing 107. In particular, a tip portion of the movable member 142 is fitted into the cavity 158 formed in the connecting piece at the front surface of the support member 141 to integrally assemble the support member 141 and the movable member 142. As can be seen from FIG. 11, the movable member 142 and the support member 141 are movable reciprocatively. In FIG. 11, the support member 141 is shown in a position in which the first outlet 131 is closed by the first ball 111 and the second outlet 132 is opened. This position is referred to hereinafter as a "first stop position P_1". The movable member 142 is movable rearwardly (towards the right in FIG. 11), via a stopping mechanism 143 described layer, by pushing the push button 110, and in response to this operation, the support member 141 forcibly displaces the first ball 111 from the first outlet 131 to open the first outlet 131 as well as fitting the second ball 112 into the second outlet 132 to close the second outlet 132. This position is referred to hereinafter as "a second stop position P_2". The movable member 142 passes into the valve casing 107 through an aperture sealed by a packing 159, and the packing 159 is fixed via a collar 160 by a guide cylinder 161 of the stopping mechanism 143 described below.

The stopping mechanism 143 comprises a guide cylinder 161 screwed into and fixed to a front surface portion of the valve casing 107, a reciprocable cylindrical cam member 171 having at one axial end reciprocable cams 171a, which axial end is inserted into an inner tip portion of the guide cylinder 161 and having its opposite axial end in contact with the push button 110, a rotatable rod-like cam member 181 having at one axial end rotatable cams 181a engageable with the reciprocable cams 171a of the reciprocable cam member 171 and being engageable at its opposite axial end with an axial end portion of the movable member 142, and a spring 191 (urging means) for biasing the movable member 142 towards the forward direction (in a direction toward the rotating cam member 181).

This stopping mechanism 143 is provided for temporarily stopping the support member 141 via the movable member 142 at the above-described first stop po-

sition P_1 and second stop position P_2, respectively.

FIG. 16 is a sectional view of the tip portion of the guide cylinder 161, which tip portion is of a generally frusto-conical shape, and FIG. 17 is a developed view of the inner surface of the tip portion of the guide cylinder 161.

As shown in FIGS. 12, 16 and 17, the guide cylinder 161 is at its tip portion of reduced internal diameter so as to define a stepped part presenting a generally annular free axial end surface facing axially inwardly of the guide cylinder 161. The stepped portion has three radially deep grooves 162 and three radially shallow grooves 163. Thus, the respective bases of the shallow grooves 163 and the respective elongate guide convex portions 165 are each defined by a respective elongate segment of the stepped part. Each such segment has a free axial end which defines a respective circumferential part of the axial end surface portion of the annular free axial end surface (in this embodiment the deep grooves 162 extend radially to the entire depth of the stepped portion, so that the annular free axial end surface is interrupted). Each such circumferential part of the annular free axial end surface is inclined axially so as to provide a circumferentially extending slope. The slopes provided by axial ends of each of the segments defining (a) the bases of the shallow groove 163 and (b) the linear guide convex portions 165 adjacent to each other together define a continuous slope, and the respective continuous slopes form a saw-blade-like shape as a whole.

FIG. 18A is a side view of the reciprocable cam member 171 and FIG. 18B is an elevational view thereof. The reciprocable cam member 171 has six reciprocable cams 171a which protrude radially and also extend in the axial direction relative to the cam member 171 and the tip portion of each cam 171a is of angular shape. The reciprocable cam member 171 is inserted into the guide cylinder 161 in a manner such that, due to their radial extent, the six cams 171a engage all of the three deep grooves 162 and the three shallow grooves 163 and can slide along them. The angular tip portions are directed toward the valve casing 107, as are the sloped axial end portions of the segments defining the elongate guide convex portions 165 and the shallow grooves 163 of the guide cylinder 161.

FIG. 19A is an elevational view of the rotatable cam member 181 and FIG. 19B is a side view thereof. A front end portion 184 of the rotatable cam member 181 is inserted into a slot 174 of the reciprocable cam member 171 and the movable member 142 is fitted into an internal face 185a in a rear end portion 185 thereof. The rotatable cam member 181 has three rotatable cams 181a each having a sloped surface at its tip portion inclined at almost the same angle as those of the sloped axial end portions of the linear guide convex portions 165 and the shallow grooves 163 of the guide cylinder 161 and each protruding radially and also extending in the axial direction relative to the rotatable cam member 181. The rotatable cams 181a can slide into a position at which they engage with the three deep grooves 162 of the guide cylinder 161, but cannot enter into the shallow grooves 163. The rotatable cam member 181 is inserted into the guide cylinder 161 after insertion of the reciprocatable cam member 171, and the tip portions of the rotating cams 181a are directed toward the reciprocable cam member 171.

As shown in FIG. 9, the spring 191 is disposed between the collar 160 fitted into the front portion of the valve casing 107 which receives the screw-threaded portion of the guide cylinder 161 and a flange portion 142a of the movable member 142. The spring 191 urges the movable member 142 towards the rotatable cam member 181 so that there is always contact between the movable member 142 and the rotatable cam member 181.

In the water purifier 101 having the above-described ball-type multi-way valve 105 according to this embodiment, the operation of the stopping mechanism 143 and the operation of switching water paths due to the pushing operation of the push button 110 are performed in the manner explained below with reference to FIG. 20.

FIGS. 20A to 20C are developed views of the inner surface of the guide cylinder 161 and the respective members showing the operation of the stopping mechanism 143.

FIG. 20A shows the relative positions of the various members, when the push button 110 has not been pushed. The reciprocable cams 171a of the reciprocable cam member 171 are inserted into the deep grooves 162 and the shallow grooves 163 of the guide cylinder 161 of the stopping mechanism 143 right up to the closed axial end portions of the grooves and, successively, the rotatable cams 181a of the rotatable cam member 181 are inserted into the deep grooves 162 so as to engage the inserted reciprocatable cams 171a, and the rotatable cam member 181 is urged into this position by the spring 191 via the movable member 142. The reciprocable cam member 171, the rotatable cam member 181 and the movable member 142 are thus stopped. As aforementioned, this condition represents a state where the support member 141 is placed at the first stop position P_1 via the movable member 142 (FIGS. 10 and 11), the first outlet 131 of the valve casing 107 is closed by the first ball 111 and the second outlet 132 is open. Namely, in this condition, the tap water introduced from the inlet 121 passes through the second outlet 132 and is supplied to the filter device 103 through the tap water transfer port 119, and after filtration, the filtered water is discharged as a purified water.

When the push button 110 is pushed by an operator, the reciprocable cam member 171 is slid in the guide cylinder 161 in a direction toward the valve casing 107, the rotatable cam member 181 is slid via the rotatable cams 181a engaging the sloped tip portions of the reciprocable cams 171a, and the movable member 142

and the support member 141 is moved toward the second stop portion P_2 (FIGS. 9 and 11). When the rotatable cams 181a emerge from the deep grooves 162, as shown in FIG. 20B, the rotatable cams 181a are slid along the slopes formed at the axial end surfaces of the segments of the stepped portion defining elongate guide convex portions 165 in the guide cylinder 161 by the biasing force of the spring 191, and as a result, the rotatable cam member 181 is rotated by a half pitch.

The first ball 111 having been fitted into the first outlet 131 is pushed up and moved by the sliding operation of the support member 141, and the first outlet 131 is opened. At that time, because the first ball 111 rolls in the valve casing 107, it is not in frictional contact with the inner bottom surface of the valve casing 107. Therefore, the first ball 111 is almost entirely unabraded, and the exchange of the balls due to the deterioration of the first ball 111 may be rare. Furthermore, because the ratio of the diameter of the first ball 111 to the inner diameter of the first outlet 131 is in the range of 1:0.3 to 1:0.8, the first ball 111 is not fitted deeply into the first outlet 131. Furthermore, because the support member 141 operates upon the first ball 111 at a position of the spherical surface eccentric from the centre of gravity of the first ball 111 toward the first outlet 131, the first outlet 131 can be opened by a fairly small force. When this operation is performed, the support member 141 rolls the second ball 112 so that it fits into the second outlet 132.

When the pushing force operated onto the push button 110 by the operator is released, the rotatable cams 181a are slid along the sloped axial end portions of the segments defining the grooves 163 by the biasing force of the spring 191, and as a result, the rotatable cam member 181 is further rotated to reach the position shown in FIG. 20C, and the rotatable cams 181a, which cannot enter into the shallow grooves 163, are engaged with and stopped by the sloped axial end portions of the shallow grooves 163 and the side faces of segments defining adjacent elongate guide convex portions 165. At that time, because the rotatable cam member 181 is urged by the spring via the movable member 142, the motion of the rotatable cam member 181 and the movable member 142 is temporarily stopped. As a result, the support member 141 is stopped at the second stop position P_2 via the movable member 142, the first outlet 131 is opened and the second outlet 132 is kept closed by the second ball 112. Namely, in this condition, the tap water introduced from the inlet 121 is discharged from the shower discharge port 118 through the first outlet 131.

When the push button 110 is pushed again, the rotating cams 181a are pushed cut up to the positions along the sloped axial end portions of the segments defining the elongate guide convex portions 165 by the reciprocable cams 171a sliding along the shallow grooves 163. Thereafter, when the pushing force of push button 110 is removed, the rotatable cams 181a are slid along the sloped axial end portions of the segments defining the elongate guide convex portions 165 by the biasing force of the spring 191, and as shown in FIG. 20A, the rotatable cams 181a are slid and moved along the next respective deep grooves 162 to be returned to the initial condition. By this operation, the support member 141 is returned to the initial condition. By this operation, the support member 141 is returned to the first stop position P_1.

Thus, the stopping mechanism 143 is compactly constructed from a small number of parts of a single guide cylinder 161, reciprocable cam member 171, rotatable cam member 181 and spring 191 relative to the plurality of outlets 131 and 132, the valve switching operation can be performed by an extremely easy and simple operation of only pushing the push button 110, and the switching of water paths can be achieved surely and easily.

Next, the filter device 103 will be briefly explained with reference to FIG. 10.

The filter device 103 of this embodiment has substantially the same structure as that of the filter-containing cartridge of the aforementioned first embodiment. Namely, a container 134 has a port 133 connected to the transfer port 119 of the valve body 102 so as to receive tap water from it, and a transparent lid 148 and a non-transparent cover 149 are provided at an upper axial end of the container 134. In the container 134, both free end portions of a down-turned U-shaped hollow fiber bundle 145 are potted into a synthetic resin member 146 provided in a cylindrical member 136 at its lower axial end, and an adsorbent layer 147 is charged between an outer surface of the cylindrical member 136 and an inner surface of the container 134. Furthermore, as in the previously described embodiment, upper and lower filters 138 and 139 are provided in the container 134 and the cylindrical member is sealingly engaged by an O-ring 137 within a short upstanding longitudinal part at the base of the container 134. Tap water from the inflow port 133 flows through the filter 138, the adsorbent layer 147, the filter 139, the hollow fiber bundle 145 to a shower discharge port 135, and the water is discharged as a purified water from the shower discharge port 135.

The valve body 102 and the filter device 103 are connected by a connecting portion 200 including a bayonet mechanism similar to that of the first embodiment for joining the transfer port 119 of the valve body 102 to the inflow port 133 of the filter device 103.

This second embodiment can be modified as follows. Although, in the above described embodiment, the multi-way valve 105 is incorporated into the water purifier 101, as is well known, use of a multi-way valve is not restricted to use in a water purifier 101. For example, for use generally in industry, another actuating device such as an air or hydraulic cylinder can be applied instead of the push button 110, and in such an apparatus, the pushing or driving operation can be automated. Fur-

thermore, although in the above embodiment the push button 110 and the movable member 142 are formed as separate members, an axial end portion of the movable member 142 remote from the balls may be constructed as a portion formed integrally with a push button portion. In such a structure, the axial end portion of the movable member 142 can function also as a push button.

Moreover, although in the above embodiment described with reference to FIGS. 8-12, two outlets 131 and 132 are provided in the valve casing 107, for example, as shown in FIG. 21, three outlets 301 to 303 may be provided, and three balls 311 to 313 corresponding to the respective outlets 301 to 303 and a support member 315 engaging these balls may be provided. Indeed, four or more outlets may be provided. Furthermore, a structure as shown in FIG. 22 may be employed wherein two outlets 321 and 322 are opened and closed by a single ball 324 and the ball 324 is moved by a support member 325.

Moreover, although in the above mentioned embodiment, the fluid to be purified is water, another liquid may be purified, or indeed, other fluids such as a gas may be purified.

Furthermore, although the above described embodiment has been explained with reference to a water purifier wherein the filter device 103 is connected directly to the valve body 102, the present invention is not particularly restricted to this type of water purifier, and for example, a water purifier according to the present invention may be another type of water purifier such as a top sink-type water purifier as described later wherein a valve body and a filter device are disposed separately and connected via a hose.

Thus, in the multi-way valve according to the second embodiment, and in a water purifier in which it is used, since the support member can displace the spherical valve elements provided in the valve casing by one pushing operation due to the pushing member (push button) via the movable member, the valve switching mechanism can be produced in a simple manner and with this mechanism a plurality of fluid outlets can be opened and closed very easily and surely.

Next, a top sink-type water purifier according to a third embodiment of the present invention will be explained with reference to FIGS. 23 to 30.

Although water purifiers having a cartridge type filter device have been explained in the above-described first and second embodiments, in this third embodiment, a top sink-type water purifier can be constructed even by using multi-way valve according to the second embodiment.

FIG. 23 is a perspective view of a top sink-type water purifier according to this embodiment of the present invention. As shown in FIG. 23, a top sink-type water purifier 401 (hereinafter, also referred to as merely "a water purifier") comprises a valve body 403 connected directly to a faucet 402 for homes, a top sink-type filter device 404 for purifying tap water and a hose 405 for connecting the valve body 403 with the filter device 404 and introducing the tap water into the filter device 404. A joint 406 is interposed between the valve body 403 and the hose 405, and a switching lever 407 is attached to the valve body 403. This joint 406 is constructed using a bayonet mechanism described later.

The structure of the valve body 403 is similar to or substantially the same as that of the structure explained with reference to the first embodiment. Therefore, hereinafter, explanation will be confined mainly to the filter device 404 and the connection structure between the filter device 404 and the valve body 403.

FIG. 24 shows a vertical section of the filter device 404. As shown in FIG. 24, the filter device 404 comprises a cylindrical outer container 440 having a bottom, a filter unit 441, an upper cover 442 supporting the filter unit 441 and fitted into the outer container 440, and a nozzle 443 for purified water.

The upper end of the outer container 440 is opened and a bottom plate 444 formed as a disc-like shape is fixed to the lower end of the outer container 440. One end of an L-shaped inlet nozzle 445 is inserted into and connected to an opening 446 defined at a central position of the bottom of the outer container 440 under liquid hermetic sealing conditions. The inlet nozzle 44 is rotatably supported by the bottom plate 444. The hose 405 is connected to an inflow port 447 provided at the other end of the inlet nozzle 445 to provide fluid communication. An acetabulum 448 is disposed on the bottom surface of the bottom plate 444 so that the filter device 404 can be easily attached to or detached from a base such as a sink.

The filter unit 441 comprises an outer layer 449 comprising, for example, an adsorbent such as activated carbon and an activated coral sand, and an inner layer 450 charged with hollow fibers.

A filter supporting plate 452 is attached to the lower end of the upper cover 442, and this filter supporting plate 452 is screwed to the outer container so as to be attachable or detachable. The filter supporting plate 452 has in it an outflow conduit 453 including a central axial bore leading to an L-shaped joint extending in a radially outer direction from a central portion of the upper surface of the filter supporting plate 452, and a short internally threaded cylindrical projection 454 depending axially from a central portion of the lower surface of the filter supporting plate 452. A discharge port 441a on an upper axial end of the filter unit 441 is defined by an externally screw threaded neck portion co-operable with the internally screw threaded projection 454 to allow attachment or detachment at will. An inflow port 441b at lower axial end of the filter unit 441 is connected to the outer surface of the inlet nozzle 445 in a manner allowing attachment or detachment so as to provide fluid communication.

One leg portion of an L-shaped connecting nozzle 456 extends outwardly and upwardly from a semi-circular depressed portion 458 having an opening 457 which

is formed at an edge portion of the upper surface of the upper cover 442, and the other leg portion of the connecting nozzle 456 is connected to the outflow port 453 of the filter supporting plate 452 so as to allow fluid communication.

One end portion of an L-shaped nozzle 443 for purified water is connected to an outer axial end portion of the connecting nozzle 456 so as to allow fluid communication, and the nozzle 443 is supported rotatably around axis "a". The other end portion of the nozzle 443 is bent downwardly, and a spray nozzle 459 is provided at this end portion.

Next, the joint member will be explained with reference to FIG. 25. FIG. 25 is an elevational view of a joint.

As shown in FIG. 25, the joint 406 is formed as a generally L-shaped cylindrical pipe. The hose 405 is fitted onto a telescopic hose-receiving port 406a of the joint 406. An aperture extending radially through the cylindrical wall of a leg of the L-shaped pipe allows fluid communication between the joint 406 and a pressure relief valve 461 fitted thereon. The pressure relief valve 461 comprises a cylindrical tube extending radially outwardly from a leg of the joint 406 (the tube depending downwardly when the joint is fitted). The tube contains at its axial end adjacent the joint 406 and surrounding the aperture a ball 467 biased towards a position in which it closes the aperture by a spring 468 inserted into and extending axially within the tube. The ball 467 and spring 468 allow control of water pressure in the joint 406. An annular adjusting member 469 screwed into an axial end of the tube remote from the joint 406 enables adjustment of the force exerted by the spring on the ball so as to allow adjustment of the pressure to an appropriate valve. Namely, when the water pressure in the joint 406 increases, the ball 467 is pressed by the water pressure against the biasing force of the spring 468 and a water path through the aperture is provided. Therefore, the water pressure can be controlled at a constant pressure and inadvertent disconnection from the hose 405 can be prevented.

A connecting port 406b of the joint 406 to be positioned adjacent to the valve body side and remote from the hose-receiving part 406a forms one end of a bayonet mechanism constituting connecting means between a transfer port 433 of the valve body 403 and the connecting port 406b of the joint 406, which will now be explained with reference to FIGS. 26 and 27. FIG. 26 is a perspective view showing such a connecting means, generally indicated as 460. FIG. 26 shows the joint 406 removed from the valve body 403 and FIG. 27 is an elevational view showing the transfer port 433 of the valve body 403 for passage of tap water from the valve body 403. In these drawings, a switching lever 407 and a spool shaft 412 have substantially the same structure as those of the aforementioned first embodiment.

As shown in FIGS. 26 and 27, the transfer port 433 extending radially from a side wall of the valve body 403 is generally cylindrical and has a free axial end defining a generally concave portion 462. This concave portion 462 is profiled so as to form one end of the bayonet mechanism. In particular, the concave portion 462 has a pair of circumferentially spaced apart notched portions 463 and circumferentially between respective notched portions a pair of circumferentially spaced apart radially inwardly projecting protrusions 464 each extending in the circumferential direction around the internal peripheral surface of the free axial and the concave portion 462. A packing 465 is fitted into the transfer port 433 towards its axial end remote from that defining the concave portion 462.

As shown in FIGS. 25 and 26, the connecting portion 406b of the joint 406 for connection to the valve body is generally cylindrical and has a free axial end defining a generally convex portion 472 for insertion into the transfer port 433 provided with the concave portion 462. This convex portion 472 is thus profiled so as to form the other end of the bayonet mechanism. Namely, the outer diameter of the convex portion 472 is set slightly smaller than the inner diameter defined by the internal circumferential periphery of the pair of protrusions 464 of the concave portion 462. In particular, the convex portion 472 is profiled so as to provide a pair of circumferentially spaced apart convex-sided radially outwardly projecting protrusions 474 each extending in the circumferential direction around the external peripheral surface of the free axial end of the connecting portion 406b defining the convex portion 472. Each convex protrusion 474 is capable of being inserted into a respective notched portion 463 of the pair thereof formed around the internal circumferential surface of the concave portion 462. A projection 475 is also formed on the internal peripheral surface of the connecting port 406b. This projection 475 is engageable with a tip portion of the spool shaft 412 extending up to the transfer port 433 of the valve body 403.

FIG. 28 is a vertical sectional view of the connecting means 460 in a condition in which the concave portion 462 of the valve body 403 and the convex portion 472 of the joint 406 are engaged with each other.

As shown in FIG. 28, by inserting the convex portion 472 into the concave portion 462 and then rotating one or both portion relative to each other around their common axis, facing surfaces of the concave-sided protrusions 464 and the convex-sided protrusions 474 are brought into engagement with each other, and the valve body 403 and the joint 406 are connected to each other. By rotation of one or both of convex and concave portions relative to one another in the reverse direction, the concave-sided protrusions 464 and convex-sided protrusions 474 are disengaged from each other so as to allow detachment of the valve body 403 from the joint 406.

As shown in FIG. 26, the circumferential surface 474a of each convex-sided protrusion 474 engaging each concave-sided protrusion 464 is inclined along the circumferential direction, so that the relative movement

of both portions in the rotational direction is thus rendered smooth and the extent of engagement of both portions can be improved. A stop 476 is provided at a circumferential end position of each convex-sided protrusion 474 for regulating the relative rotational movement of both portions 474 and 462 around the axis. When the end portion of the concave-sided protrusion 464 comes into contact with this stop 476 of the convex-sided protrusion 474, both protrusions 464 and 474 can engage with each other appropriately, and the internal circumferential surface of the convex portion 472 presses the packing 465 (FIG. 28) so that the convex portion 472 and the concave portion 462 are engaged in a liquid hermetic sealing condition.

FIGS. 29 and 30 are vertical sectional views of the connecting means 460 for explaining the connecting operation.

In a case where the joint 406 connected to the hose 405 is connected to the valve body 403 fixed in a vertically standing condition, in the first step, as shown in FIG. 29, the hose-receiving port 406a of the joint 406 is set in a vertically standing condition so that it is directed downwardly. In this condition, the convex-sided protrusions 474 of the convex portion 472 are inserted into the notched portions 463 of the concave portion 462. In the second step, as shown in FIG. 30, the joint 406 is rotated in a counterclockwise direction through an angle of about 90 degrees as viewed from the side of the valve body 403. By this operation, the concave-sided protrusions 464 assume a position axially between an axial end of the connecting port 406b remote from the free axial end and the convex-sided protrusions 474 (FIGS. 26 and 28) of the convex portion 472 at the free axial end of the connecting part 406b. As the joint 406 is rotated, so the respective concave-sided protrusions 464 gradually engage the slopes 474a of the respective convex-sided protrusions 474, and when the circumferential end portions of the concave-sided protrusions 464 come into contact with the respective stops 476, the valve body 403 and the joint 406 are connected in a liquid hermetic sealing condition. At that time, the joint 406 is set in a horizontal condition (FIG. 30).

Thus, in the water purifier 401 according to this embodiment, the joint 406 connected to the hose 405 can be connected to the valve body 403 substantially merely by the second step. Therefore, as compared with the conventional screw-type joint, the joint 406 can be connected to the valve body 403 easily and appropriately. Furthermore, when the joint 406 is connected by setting the hose-receiving port 406a of the joint 406 in a vertically standing condition so that it is directed upwardly (contrary to the above-described condition), connection can be made inserting the convex portion 472 into the concave portion 462 and rotating it by an angle of about 90 degrees. Since the hose-receiving port 406a is set in a horizontal direction (contrary to the above-described direction), the setting position and direction thereof can be appropriate changed so that the connected hose 405 is not obstructed.

A situation may arise where the joint 406 is detached from the valve body 403 in a condition where the cam of the spool shaft 412 opens the water path communicating the filter device 404, that is, the switching lever 407 is set at a position for water purification (refer to the first embodiment). In such a case, during detachment, the projection 475 provided on the inner surface of the convex portion 472 engages the tip portion of the spool shaft 412 extending through the transfer port 433. Thus, during the relative rotation of the convex portion 472 and the concave portion 462 around the axis, simultaneously the projection 475 rotates the spool shaft 412 such that the above-described water path is closed (FIG. 26). By this operation, even when the joint 406 is detached from the valve body 403, tap water does not escape from the transfer port 433.

In the top sink-type water purifier according to the third embodiment, since a multi-way valve similar to that of the first embodiment is employed, the degree of movement of a selected valve element necessary for opening and closing a selected water path can be decreased as compared with conventional multi-way valve, the multi-way valve can be constructed so as to be small in size as a whole and the amount of resident fluid in the valve can be reduced. Moreover, when the valve elements are taken off or exchanged, because only the upper portion of the valve casing need be opened, the operation therefore can be facilitated as compared with the operation of conventional valves wherein almost the whole of the valve must be disassembled.

Furthermore, because the transfer port of the valve body and the joint connected to the hose are connected to each other by the above-described bayonet mechanism, the valve body and the joint (the hose) can be attached to and detached from each other very easily and adequately. Moreover, because the attaching condition and the direction of the joint including the hose can be appropriately changed, the hose can be appropriately set in a direction desired for attachment or detachment so that the hose is not obstructed.

Furthermore, in the bayonet mechanism, by inclining at least one side surface of the convex-sided protrusions and the concave-sided protrusions along the circumferential direction, the convex portion and the concave portion can rotate smoothly relative to one another around the axis and yet both protrusions can engage with each other to provide good contact when both portions are connected to each other. During the connecting operation, the stop formed on the end portion of at least one of the convex-sided protrusions and the concave-sided protrusions can appropriately regulate the relative positions of the convex portion and the concave portion in their rotational direction around the axis, and the valve body and the joint with the hose can be connected so as to assume an appropriate direction as well as ensuring the prevention of water leakage at the connecting portion.

Claims

1. A multi-way valve comprising:

a valve casing (18) having a valve inlet (15) for entry of fluid into the valve and a plurality of valve outlets (16, 17, 17a) for supply of fluid from the valve;
a first chamber (18e)and a second chamber (18f) each within the valve casing, the first chamber (18e) communicating with the valve inlet (15) and the second chamber (18f) communicating with the valve outlets (16, 17, 17a), respectively;
a partition (18d) disposed between the first and second chambers (18e, 18f) and separating the first and second chambers from one another, the partition (18d) having a plurality of apertures (18a, 18b, 18c) therein allowing communication between the first and second chambers (18e, 18f) and providing respective fluid inlets to respective fluid paths, within the second chamber (18f), communicating one with each respective valve outlet (16, 17, 17a) of the said plurality thereof;
a plurality of valve elements ($18a_1$, $18b_1$, $18c_1$) each associated with a corresponding said aperture (18a, 18b, 18c) and movable between a first portion in which the corresponding said aperture is closed thereby and a second position in which the corresponding said aperture is in an open condition;
valve operating means comprising a plurality of cams (23a, 23b, 23c) each associated with a corresponding said valve element ($18a_1$, $18b_1$, $18c_1$) and cooperable with the said valve element ($18a_1$, $18b_1$, $18c_1$) so as to allow selective movement of each valve element ($18a_1$, $18b_1$, $18c_1$) between the said first and second portions;
the said plurality of valve elements ($18a_1$, $18b_1$, $18c_1$) being disposed generally in one of the first and second chambers (18e, 18f) and the said valve operating means being disposed generally in the other of the first and second chambers (18e, 18f) so that the said partition (18d) is disposed generally between the said plurality of valve elements ($18a_1$, $18b_1$, $18c_1$) and valve operating means;
each said aperture (18a, 18b, 18c) in the partition (18d) allowing the said cooperation between the valve element ($18a_1$, $18b_1$, $18c_1$) corresponding with the aperture (18a, 18b, or 18c) and the cam (23a, 23b or 23c) corresponding with the valve element so as selectively to open or close each said aperture and therefore select which said fluid path is to be open and which is to be closed.

2. A multi-way valve according to claim 1, wherein the said plurality of valve elements ($18a_1$, $18b_1$, $18c_1$) is disposed generally in the first chamber (18e) and the valve operating means is disposed generally in the second chamber (18f).

3. A multi-way valve according to claims 2, wherein the weight of each valve element ($18a_1$, $18b_1$, $18c_1$) and fluid pressure is capable of biasing each valve element ($18a_1$, $18b_1$, $18c_1$) towards the first position and the valve operating means is operable to effect cooperation between a selected said cam (23a, 23b, 23c) and the valve element corresponding therewith to urge the valve element ($18a_1$, $18b_1$, $18c_1$) away from the said first position against the said bias.

4. A multi-way valve according to any preceding claim, wherein the valve elements ($18a_1$, $18b_1$,$18c_1$) are spherical elements.

5. A multi-way valve according to claim 4, wherein each of the valve elements comprises a core composed of a rigid material and an elastic material provided on the surface of the core.

6. A multi-way valve according to any preceding claim, the valve elements ($18a_1$, $18b_1$, $18c_1$) and respective apertures (18a, 18b, 18c) associated therewith are spaced apart from one another in a longitudinal direction and the valve operating means, additionally comprises a rotatable body (23) from which the cams (23a, 23b, 23c) project radially, the cams (23a, 23b, 23c)being spaced apart from one another along an axial direction of the rotatable body (23) parallel to the said longitudinal direction so as to lie in register with selected spaced apart apertures (18a, 18b, 18c).

7. A multi-way valve according to claim 6, wherein at least a first said cam (23a) is displaced circumferentially of the rotatable body (23) relative to at least a second said cam (23b), so that on rotation of the rotatable body (23a) to a first position at least the first cam (23a) assumes a position of cooperation with the valve element ($18a_1$) corresponding therewith and at least the second cam (23b) assumes a position free from cooperation with the valve element (23b) corresponding therewith, while on rotation of the rotatable body to a second position at least the first cam (23a) assumes a position free from cooperation with the valve element corresponding therewith and at least the second cam (23b) assumes a position of cooperation with the valve element (23b) corresponding therewith, whereby selection of the position of rotation of the rotatable body (23) allows the said selection of which said fluid path is to be open and which is to

be closed.

8. A multi-way valve according to claim 7 or claim 8, wherein the respective fluid paths are formed between the respective said fluid inlets, provided by the respective said apertures (18a, 18b, 18c), paths and the respective said valve outlets (16, 17, 17a) and the respective fluid paths are separated from each other by sealing means (23d, 23e) carried by the rotatable body (23).

9. A multi-way valve comprising:

a valve casing (102) having a fluid inlet (121) and a plurality of fluid outlets (132, 133);
at least one spherical valve element (111, 112) disposed in the valve casing (102) for opening and closing the fluid outlets (132, 133);
a valve operating means operable on the or each said spherical valve element so as to be capable of displacing the or each said spherical valve element (111, 112) from a first position in which at least a first said outlet is open (132) and at least a second said outlet (133) is closed to a second position in which at least the first said outlet (132) is closed and at least the second said outlet is open (133).

10. A multi-way valve according to claim 9, wherein the valve operating means comprises:

a movable support member (141) capable of supporting the or each said spherical valve element (111, 112) during the said displacement thereof; and
means (142, 143) for imparting linear motion to the movable support member (141), thereby imparting linear motion to the or each said spherical valve element (111, 112) to effect the said displacement thereof.

11. A multi-way valve according to claim 10, wherein the means (142, 143) for imparting linear motion to the movable support means is capable of imparting a reciprocating motion.

12. A multi-way valve according to claim 10, which additionally comprises biasing means (191) biasing the or each spherical element (111, 112) towards one of the said first and second positions thereof.

13. A multi-way valve according to claim 12, which additionally includes a stop mechanism (143) capable of temporarily retaining the or each spherical element (111, 112) in the other of the said first and second positions against the said bias.

14. A multi-way valve according to claim 13, wherein the stop mechanism comprises:

a guide cylinder (161) having an internal circumferential periphery, an axial extent of which internal periphery is of reduced diameter such as to provide, within the guide cylinder (161), a stepped portion presenting a generally annular axial end face thereof;
which stepped portion has therein a plurality of axially extending grooves (162, 163) spaced apart from one another circumferentially of the guide cylinder (161), each groove (162, 163) being a deep groove (162) or a shallow groove (163) of a depth less than that of the deep grooves (162) and each of the deep and shallow grooves (162, 163) being alternate respective said grooves, the grooves thereby defining a plurality of elongate guide portions (169) disposed circumferentially between each said groove (162,163);
whereby circumferential parts of the annular axial end face of the stepped portion are provided by respective axial ends of each respective said guide portion (165) and by respective axial ends of each respective shallow groove base-defining portion, each said circumferential part provided by the said respective axial ends of the guide and shallow groove base-defining portions being inclined axially so as to define a respective circumferentially extending slope;
a reciprocable cam member (171) having cams (171a) receivable within and slidable along each of the said deep and shallow grooves (162, 163);
a rotatable cam member (181) have cams (181a) receivable within and slidable along each of the deep grooves (162) and rotatably only when outside the deep grooves (162);
a push button (110) capable of effecting reciprocating movement of the reciprocable cam member (181) within the guide cylinder (161); and
the rotatable cam member (181) being cooperable with the reciprocable cam member (171) and grooved stepped portion of the guide cylinder (161) to assume either a first or second position corresponding respectively to the first or second position of the spherical valve element (111, 112), whereby the stop mechanism (143) is capable of assuming a first condition in which the cams (171a) of the reciprocable cam member (171) and the cams (181a) of the rotatable cam member (181) are disposed within respective deep grooves (162) and the or each spherical valve element (111, 112) assumes one of the first and second positions; or
a second condition in which the cams (181a) of

the rotatable cam member (181) are disposed outside the respective deep grooves (162) and the or each spherical valve element (111, 112) assumes the other of the first and second positions; and

when in the first condition, the stop mechanism is responsive to actuation of the push button (11) whereby forward sliding movement of the reciprocable cam member (171)causes the cams (181a) of the rotatable cam member (181) to slide out of the deep grooves (162) and assume a position of co-operation with the said axially inclined circumferential parts of the annular axial end face of the stepped portion so as to rotate to, and be held by the biasing means at, a position in which the cams (181a) of the rotatable cam member (181) are circumferentially spaced from the deep grooves (162) and the stop mechanism (143) assumes the second condition; and

when in the second condition, the stop mechanism (143) is responsive to actuation of the push button (110), whereby the rotatable cam member (181) is pushed out of the said held position spaced from the deep grooves (162) so that further rotation of the rotatable cam member (181) caused thereby brings the cams (181a) thereof into circumferential register with the deep grooves (162) to allow the stop mechanism (143) to return to the said first condition thereof.

15. A multi-way valve according to any one of claims 10 to 14, which additionally includes guide means (153, 154) for preventing rotation of the said support member (141) during the said linear motion thereof, which guide means (153, 154) comprises a protrusion (153) from one of the support member (141) and an element (154) fixed within the valve casing (102) and an elongate recess in the other of the support member (153) and the element (154) fixed within the valve casing (102).

16. A multi-way valve according to any of claims 10 to 15, wherein the support member (141) comes into contact with a spherical surface of the or each spherical element (111, 112) at a position eccentric from the centre of gravity of the or each spherical element and disposed between a plane containing the or each centre of gravity and the fluid outlets (131, 132).

17. A multi-way valve according to any one of claims 10 to 16, wherein the support member (141) is provided with at least one apertured recess (151, 152) in which the or each respective spherical valve element (111, 112) sits, the or each aperture allowing the or each spherical valve element (111, 112) to extend into a fluid outlet (131, 132) on the valve casing (102) to effect closure thereof.

18. A multi-way valve according to any one of claims 9 to 17, wherein each said spherical valve element (111, 112) has a diameter of D and each said fluid outlet (131, 132) for closure thereby has an internal diameter d providing a ratio D:d in the range 1:0.3 to 1:0.8.

19. A water purifier (10) having a multi-way valve for switching untreated water flowing into at least one of a plurality of outflow destinations and means for filtering untreated water received from the multi-way valve, which said multi-way valve is a valve according to any preceding claim.

20. A water purifier according to claim 19, wherein the filtering means comprises an exchangeable cartridge-type filter device (12).

21. A water purifier according to claim 19, wherein the filtering means comprises a top sink-type filter device (404).

22. A multi-way valve comprising:

a valve casing (18) having:

(1) one of (a) a valve inlet (15) for entry of fluid into the valve and a plurality of valve outlets (16, 17, 17a) for supply of fluid from the valve to different respective locations; and

(b) a plurality of valve inlets for receipt of fluid from different respective sources and a valve outlet for supply of a mixture of the fluids from the respective sources;

(2) a first chamber (18e) communicating with the or each valve inlet (15);

(3) a second chamber (18f) communicating with the or each valve outlet (16, 17, 17a);

(4) a partition (18d) having a plurality of apertures (18a, 18b, 18c) therein;

(5) means (23d, 23e) defining one of:

(a) separate respective fluid paths within the second chamber leading respectively from each said aperture (18a, 18b, 18c) to a corresponding said outlet (16, 17, 17a) of the plurality thereof; and

(b) separate respective fluid paths within the first chamber leading respectively from each said fluid inlet of a plurality thereof to a corresponding said aperture;

(6) a plurality of valve elements ($18a_1$, $18b_1$, $18c_1$) disposed generally within one of the first and second chambers (18e, 18f) and co-operable one with each respective said aperture

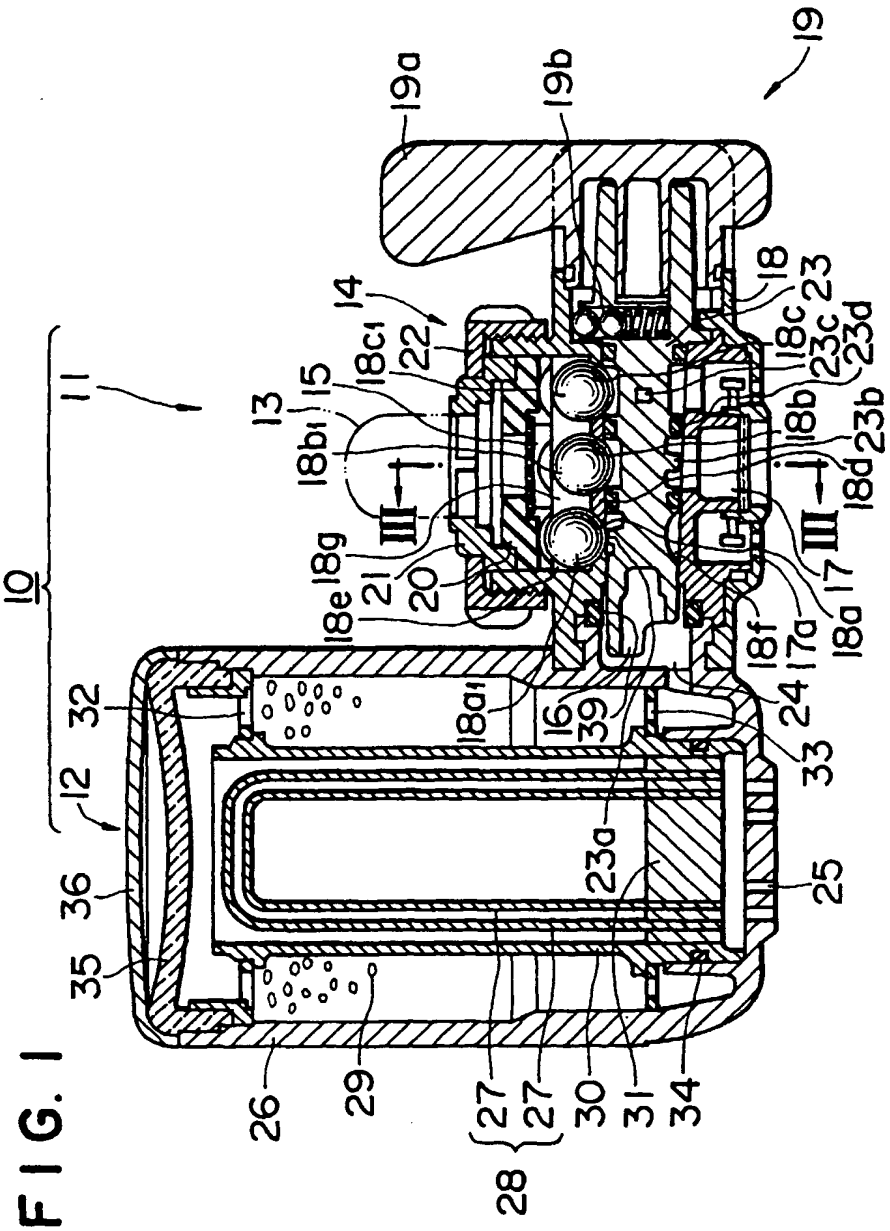
(18a, 18b, 18c) so as to be capable of closing the respective aperture; and
(7) valve operating means operable within the other of the said first and second chambers (18e, 18f) to push any one or more said valve element(s) ($18a_1$, $18b_1$, $18c_1$) away from the or each respective aperture (18a, 18b, 18c) and thereby selectively open one or more of the said fluid paths.

23. A multi-way valve according to claim 22, wherein the valve elements (18a, 18b, 18c) are disposed generally within the first chamber (18e) and are each capable of closing a respective aperture as a result of the weight of the valve element ($18a_1$, $18b_1$, $18c_1$) and fluid pressure thereon.

24. A method for distributing a fluid introduced from a single fluid inlet (15) to at least one of a plurality of fluid outlets (16, 17, 17a), or mixing fluids introduced from a plurality of fluid inlets by supplying said fluids to a single fluid outlet, characterized in that the distributing or mixing method comprises the steps of:

providing a partition (18d), having a plurality of apertures (18a, 18b, 18c) therein, between a first chamber (18e) communicating with the single fluid inlet (15) or the plurality of fluid inlets and a second chamber (18f) communicating with the plurality of fluid outlets (16, 17, 17a) or the single fluid outlet;
providing one of:

(a) separate respective fluid paths within the second chamber (18f) leading respectively from each said aperture (18a, 18b, 18c) to a corresponding said outlet (16, 17, 17a) of the plurality thereof; and
(b) separate respective fluid paths within the first chamber (18e) leading respectively from each said fluid inlet of a plurality thereof to a corresponding said aperture;
(c) closing any one or more of the said apertures (18a, 18b, 18c) in the partition (18d) by means of a or a respective valve element ($18a_1$, $18b_1$, $18c_1$) provided in the first chamber (18e) and in register with the or each respective aperture (18a, 18b, 18c) to be closed, which closure is effected by utilizing the weight of each valve element (18a, 18b, 18c) and fluid supply pressure; and
(d) selectively driving upwardly at least one of the valve elements from a closure position thereof by application of a force upwardly from the second chamber (18f), so as to push up the or each corresponding selected valve element ($18a_1$, $18b_1$, $18c_1$) and thereby selectively open at least one said fluid path in dependence upon a desired predetermined fluid distribution or mixing.


19
19a
19b
18
14
22
18c1
23
23c
23d
18c
11
13
15
18b1
18b
23b
18d
III
III
10
18g
21
20
18e
17
18a
17a
18f
24
32
18a1
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35
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28

FIG. 1

FIG. 2

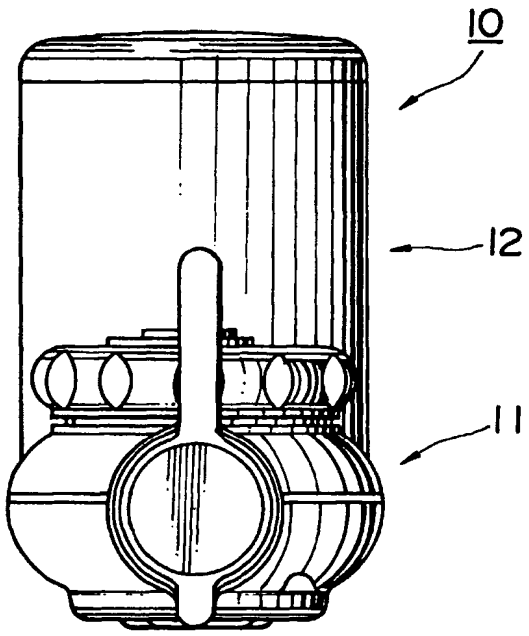

FIG. 3

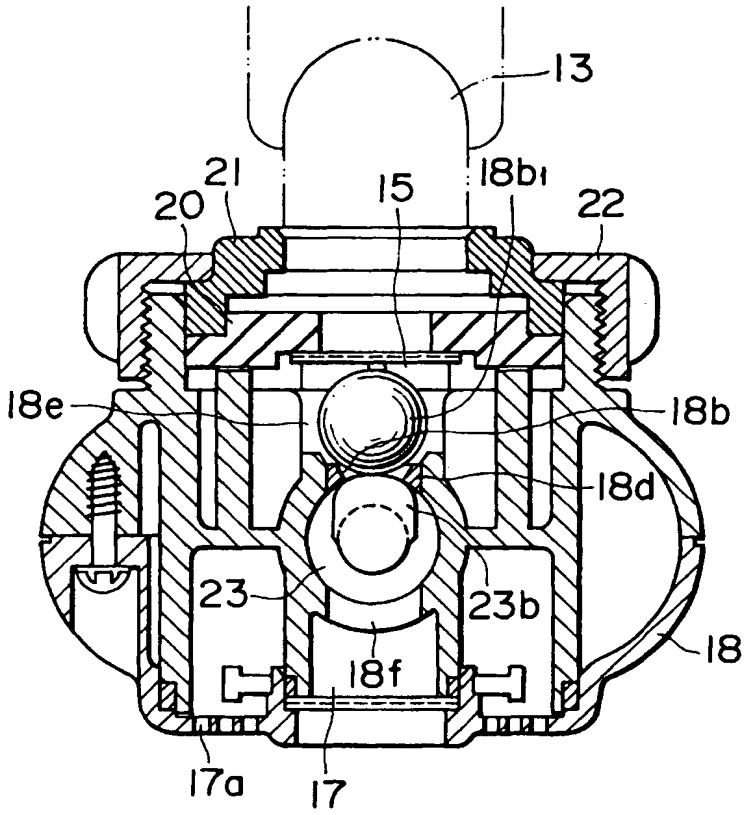

FIG. 4

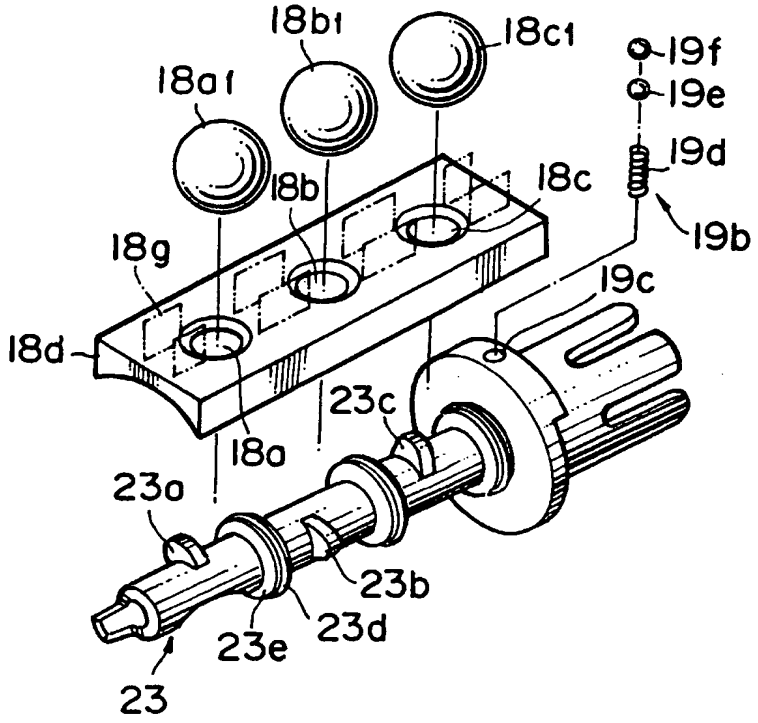
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FIG. 5

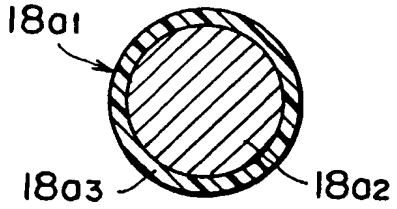
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FIG. 6

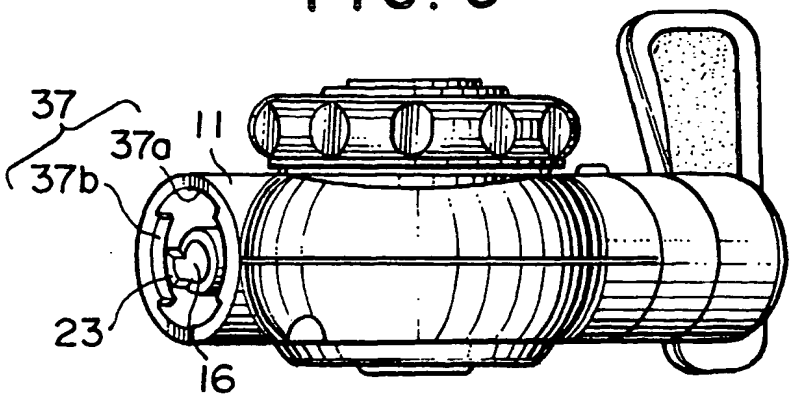


FIG. 7

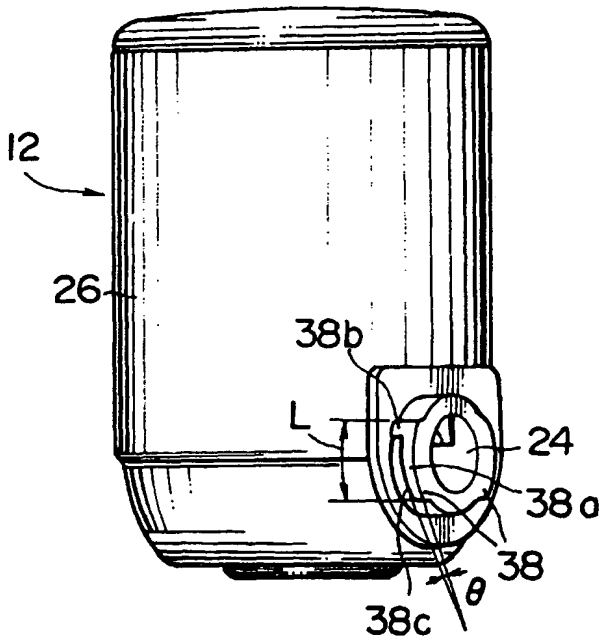
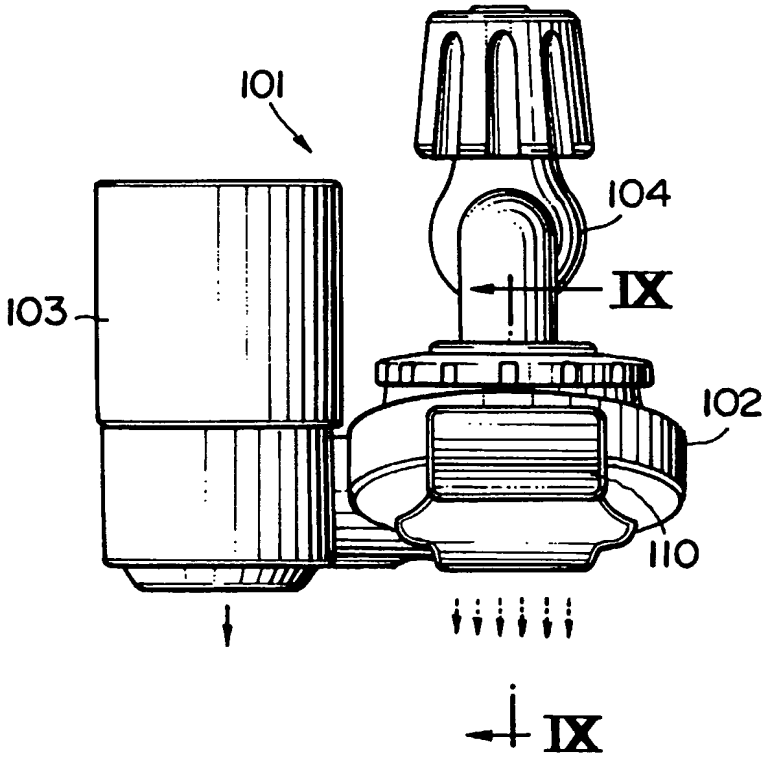


FIG. 8



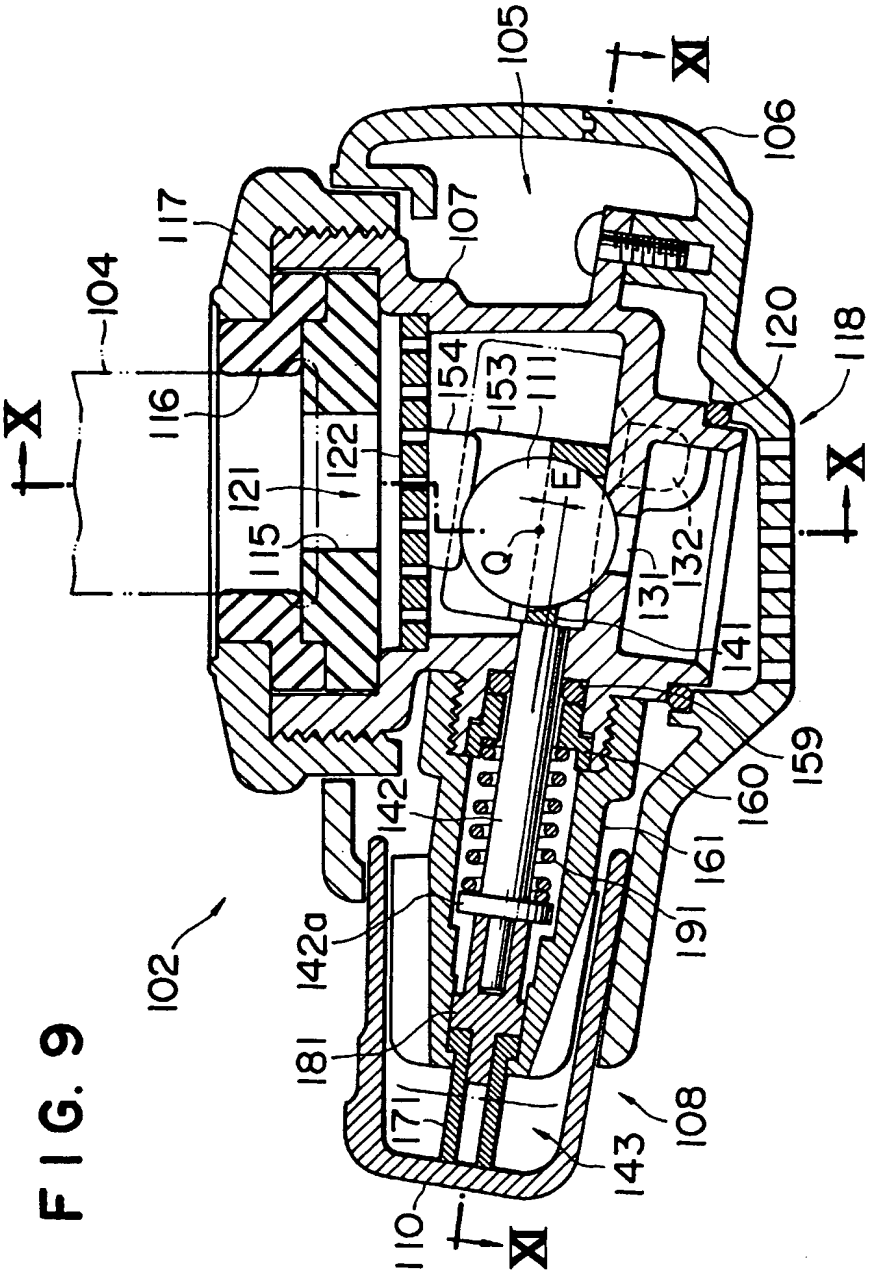

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FIG. 9

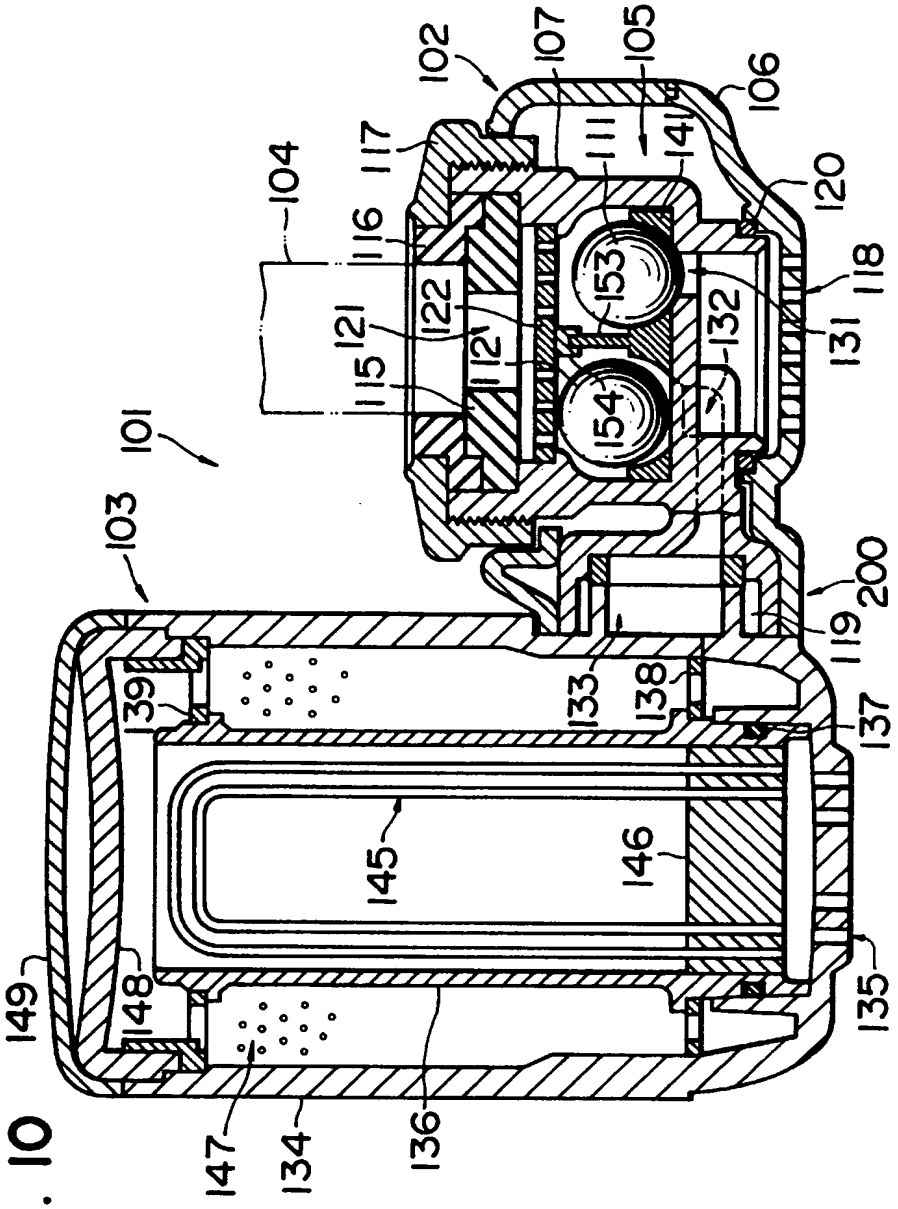
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FIG. 10

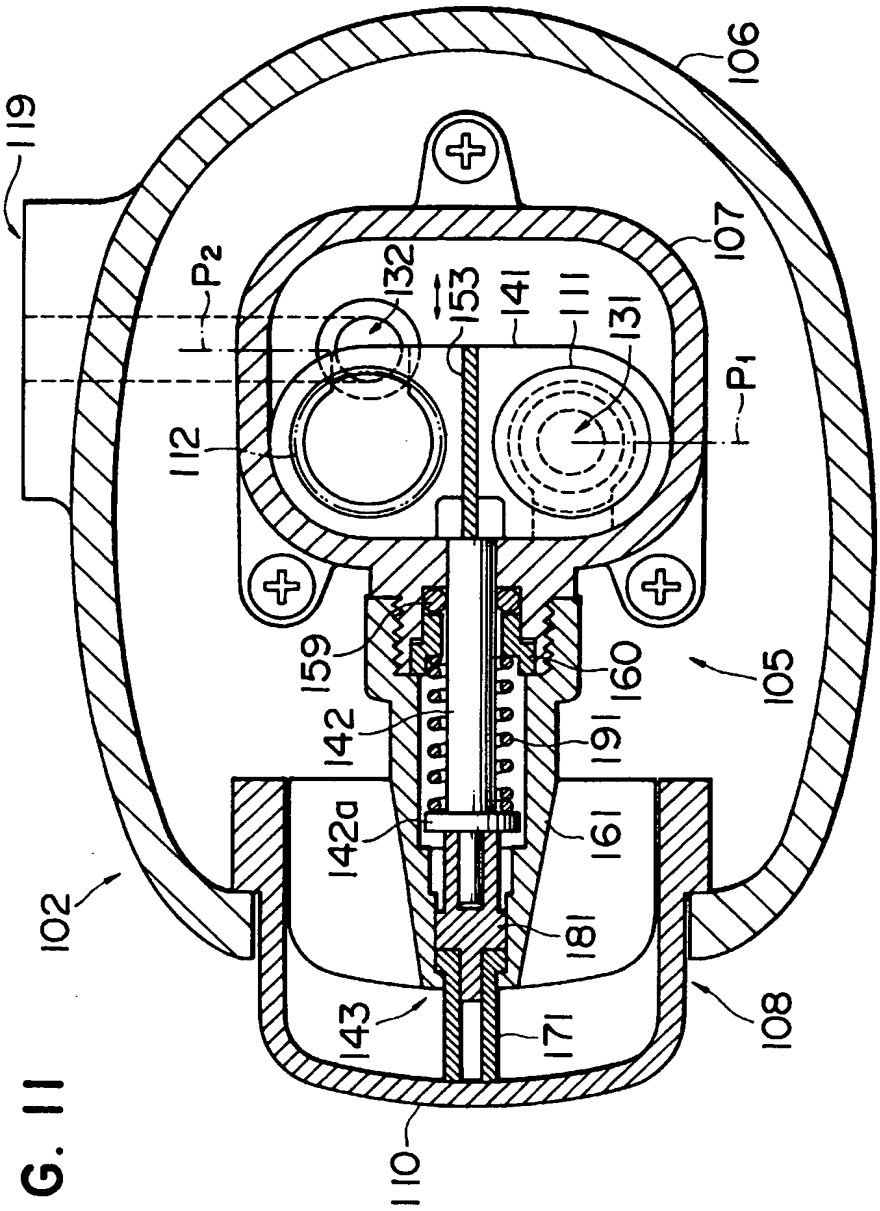
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FIG. 11

FIG. 12

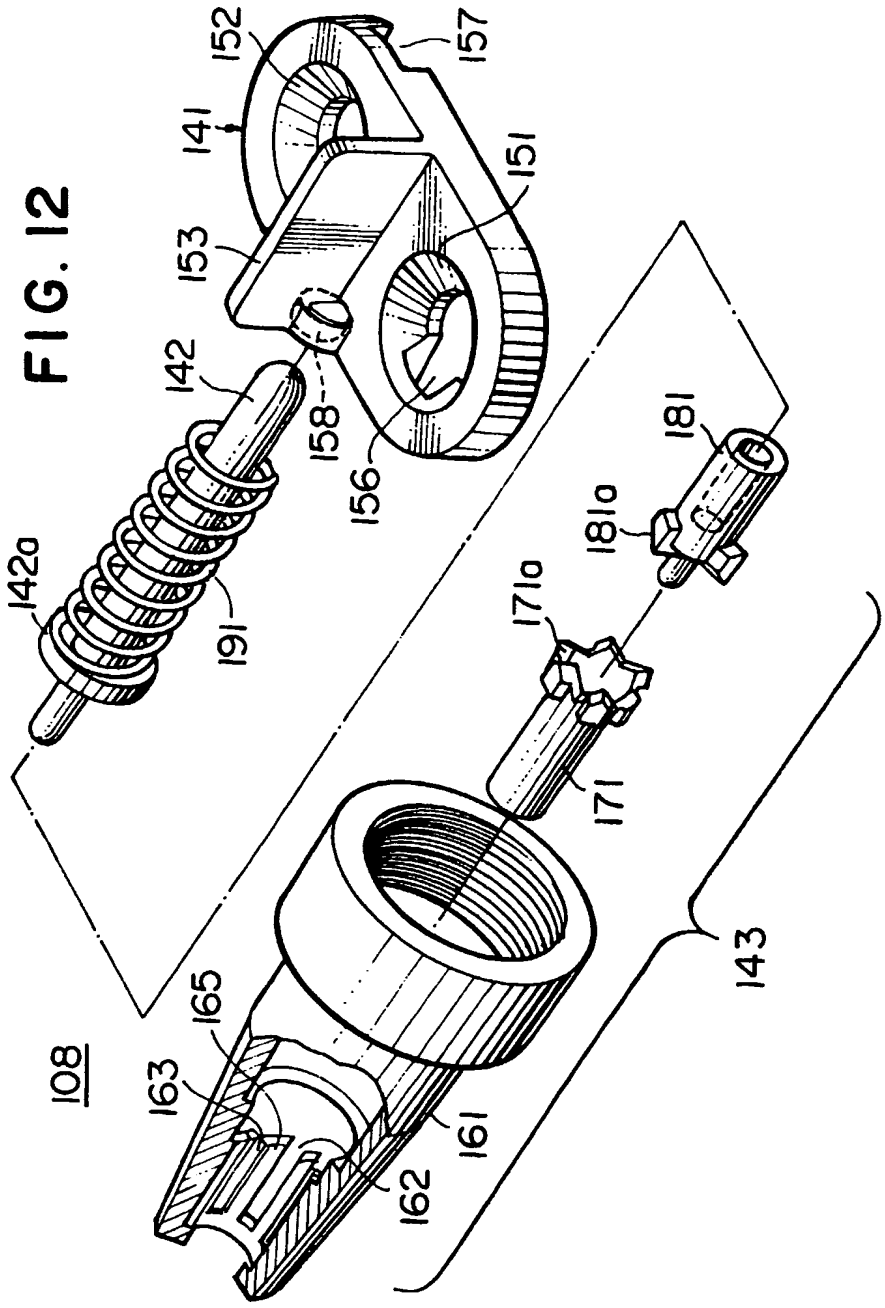
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FIG. 13

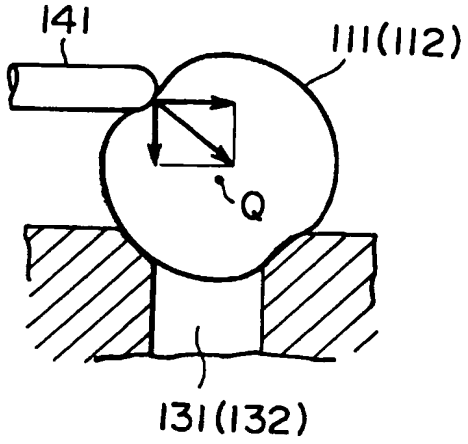

FIG. 14

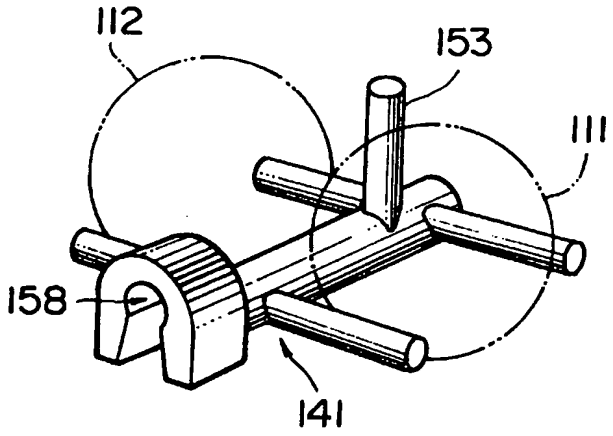

FIG. 15

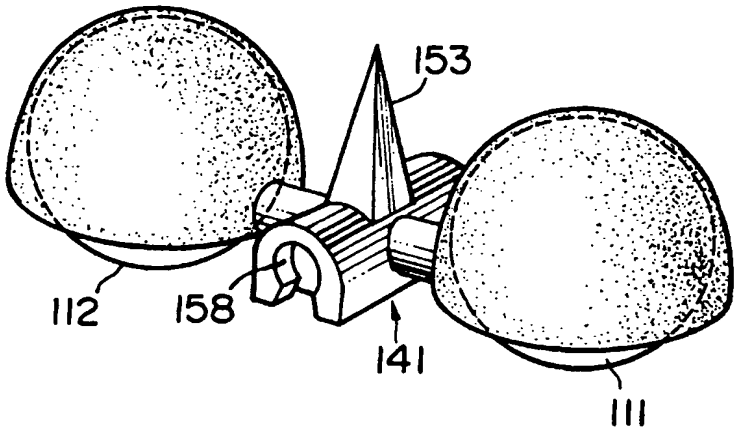

FIG. 16

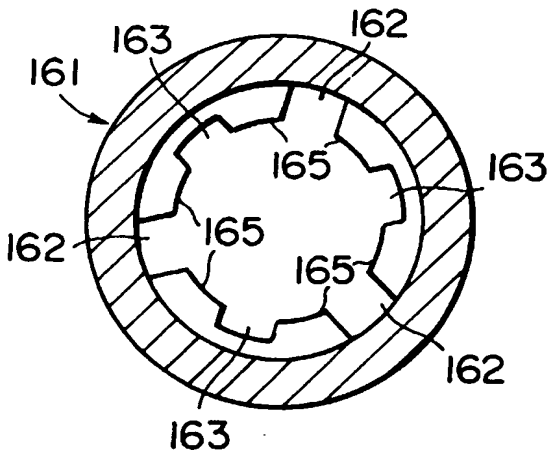

FIG. 17

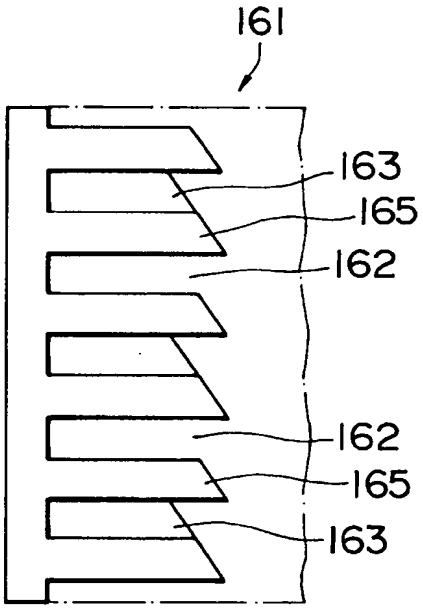

FIG. 18A

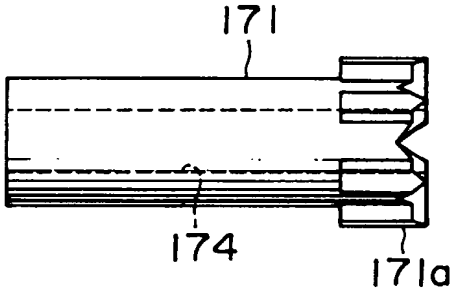

FIG. 18B

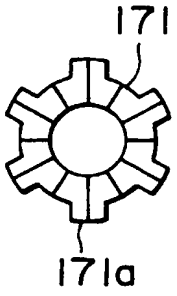

FIG. 19A

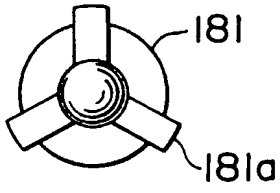

FIG. 19B

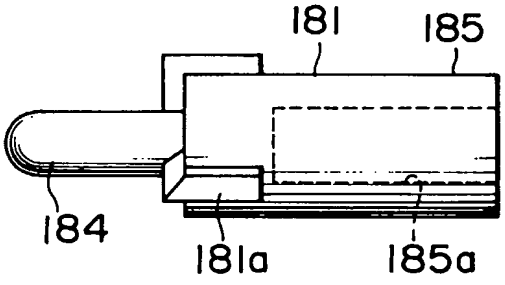

FIG. 20C

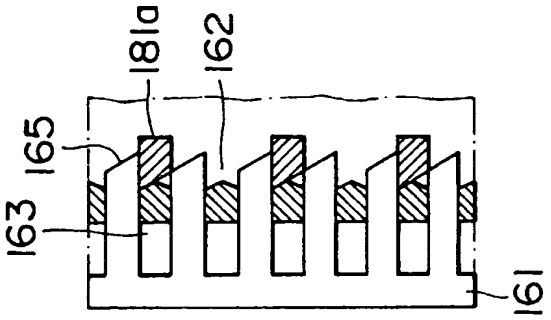

FIG. 20B

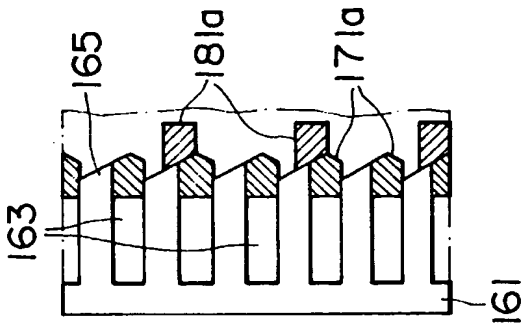

FIG. 20A

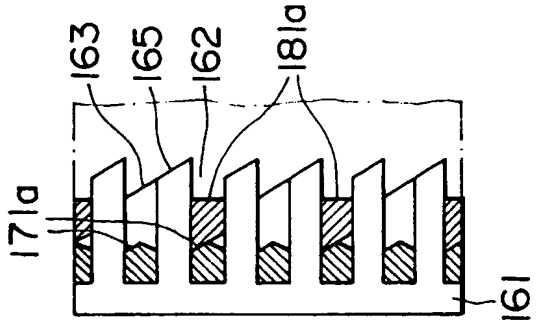

FIG. 21

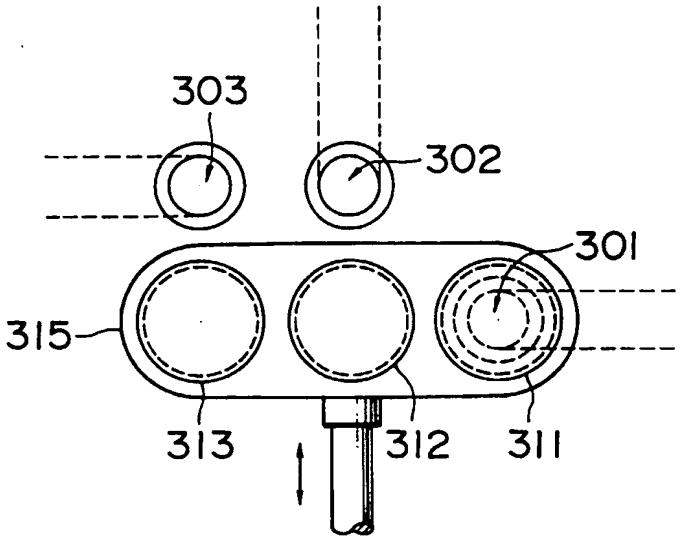

FIG. 22

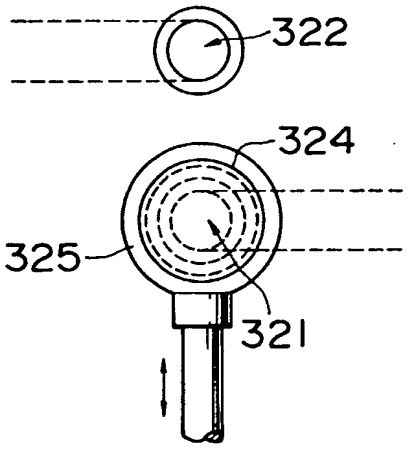

FIG. 23

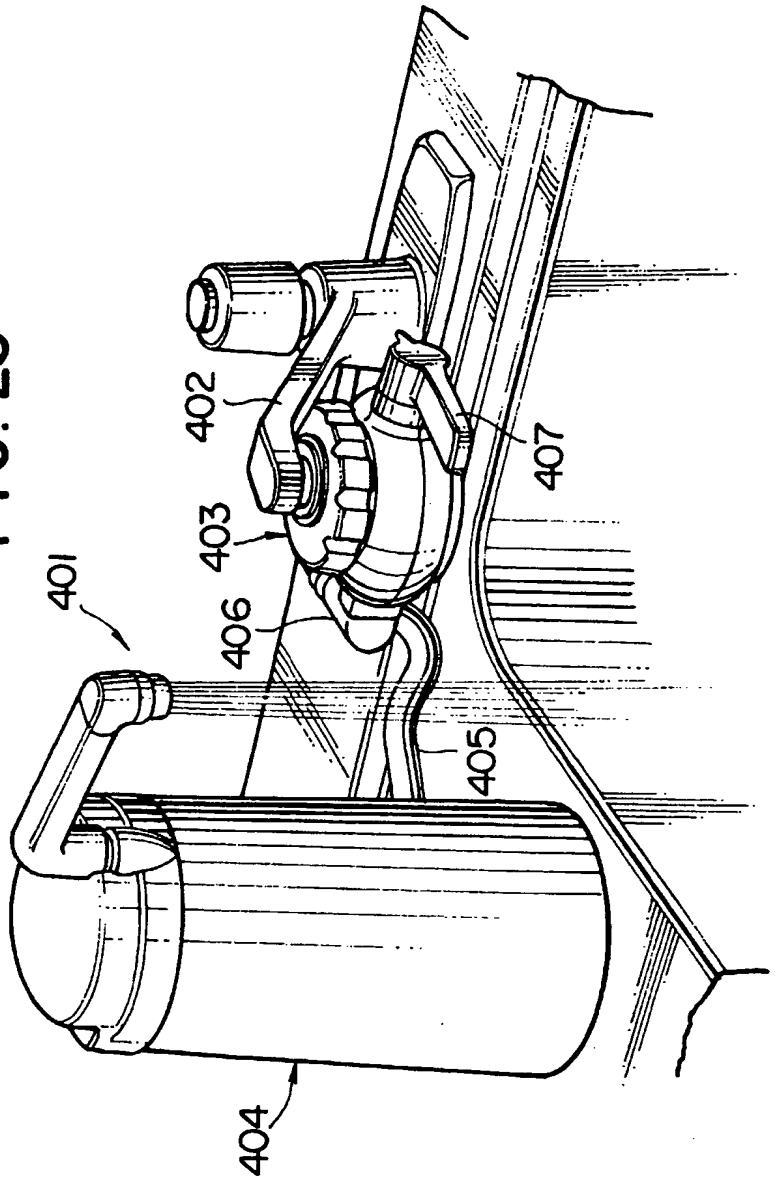

FIG. 24

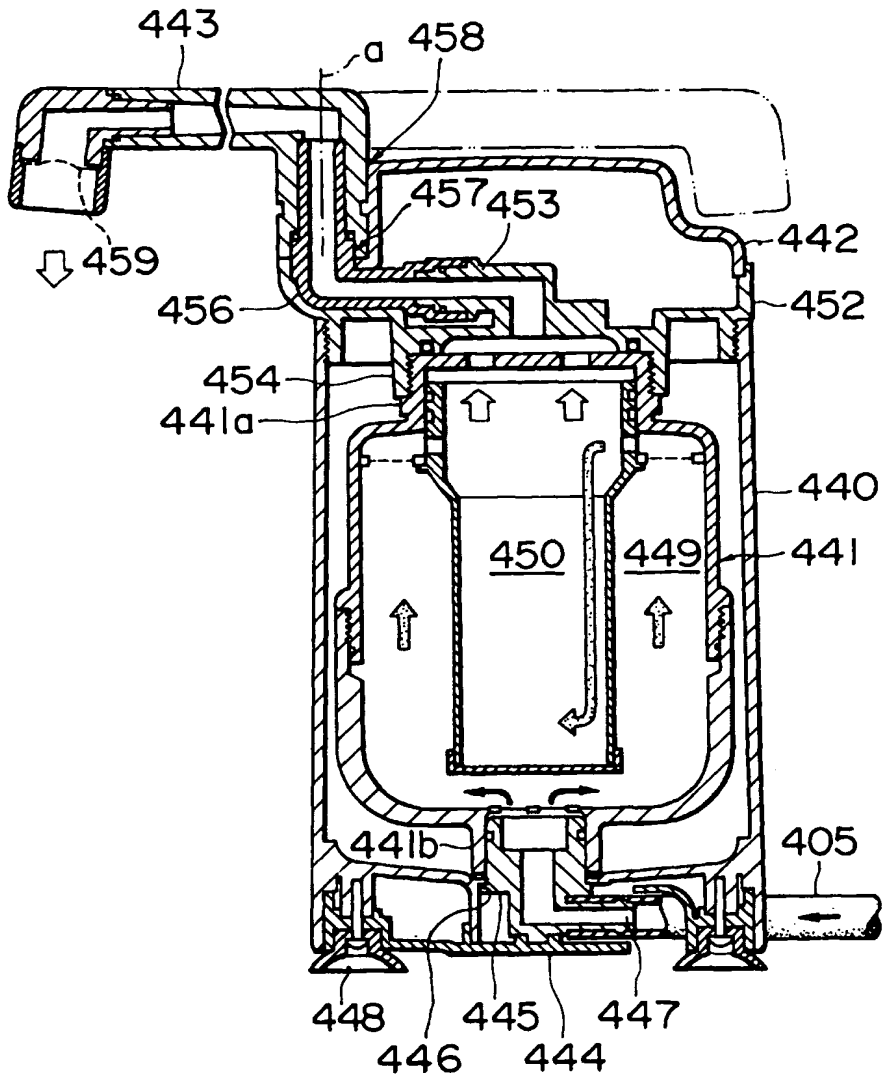
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FIG. 25

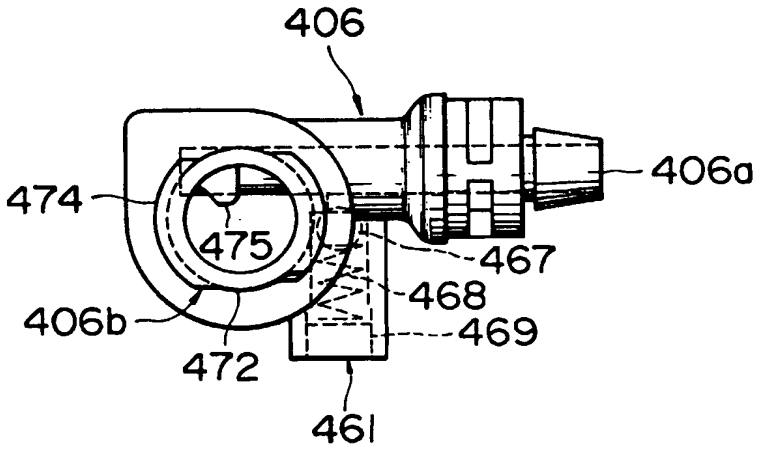

FIG. 26

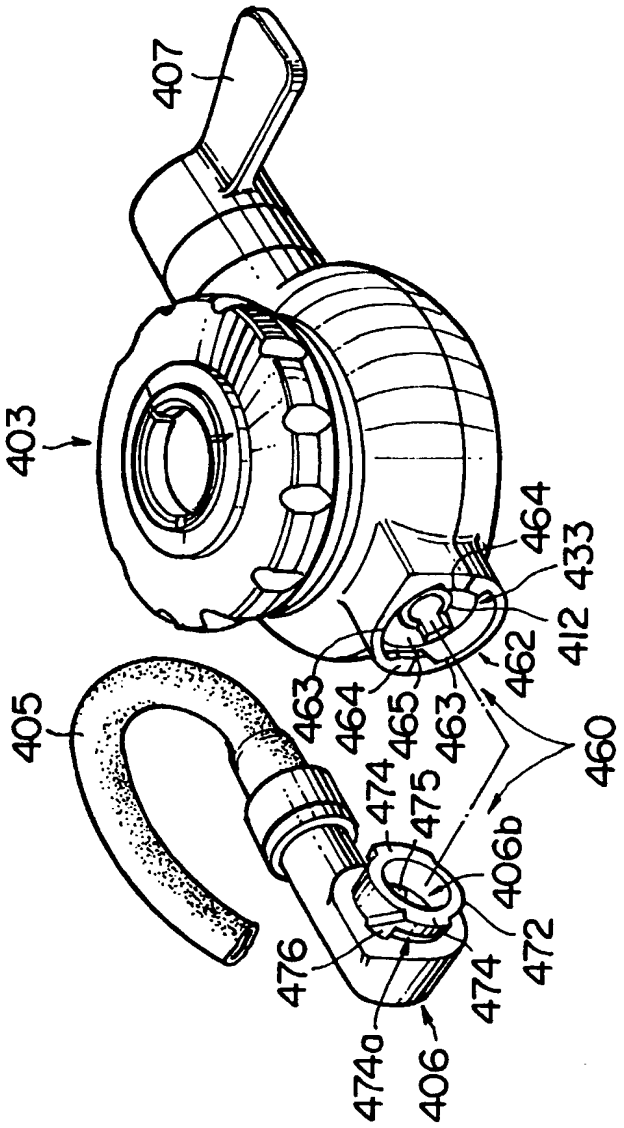
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FIG. 27

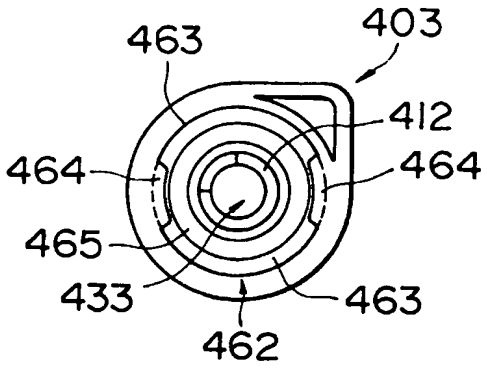
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FIG. 28

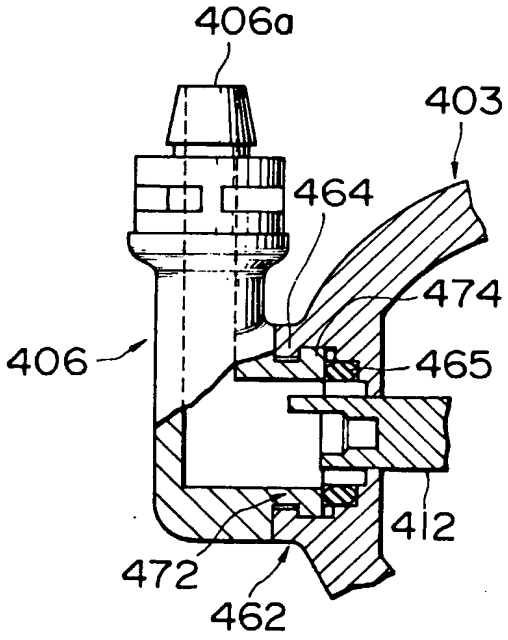
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FIG. 29

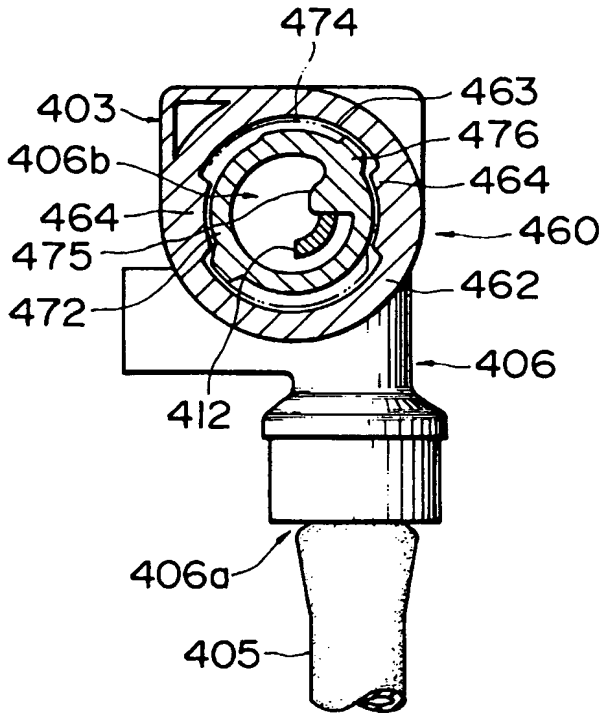
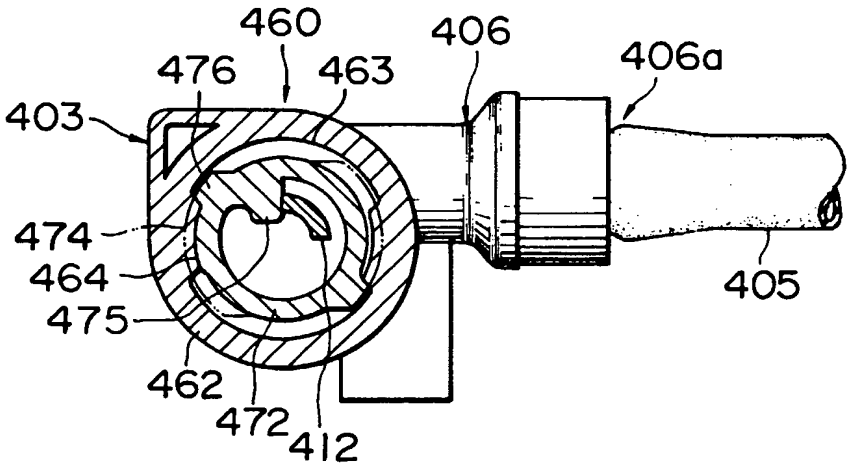


FIG. 30



European Patent Office

PARTIAL EUROPEAN SEARCH REPORT

under Rule 46, paragraph 1 of the European Patent Convention

Application Number EP 96 30 8321

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 433 453 A (INAX) * figures 9B,10B,11B * ---	1,19,22, 24	F16K11/056 B01D35/04
A	GB 1 085 546 A (RANDOLPH) * figures 3,4 * ---	1,19,22, 24	
A	DE 10 16 083 B (HERMANN WALDNER) * figure 1 * ---	1	
A	GB 2 257 052 A (SUNTORY) * figure 1 * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F16K
B01D

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

The present partial European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 February 1997	Lokere, H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C37)

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions, or groups of inventions, namely:

1. Claims 1-8,19-24 : Multi-way valve, 2 separate chambers, partition; purifier; method.
2. Claims 9-18 : Multi-way valve with linearly moving actuator.